BUREAU OF SHIPS GROUP TECHNICAL INSPECTION REPORT

OVERALL SUMMARIES OF TARGET VESSELS

TEST ABLE

VOLUME 1 OF 2

OPERATION CROSSROADS

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INTRODUCTION

The report of damage on each target vessel contains an Overall Summary of damage for that vessel. In addition, for convenience and ready reference all Overall Summaries for Test Able have been bound in two volumes.

This volume, Volume 1 of 2 contains the Summaries of the following vessels:

(a) Battleships

(b) Cruisers

(c) Aircraft Carriers

(d) Destroyers

(e) Submarines

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TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Drafts before test were 30' 3" forward and 31' 0" aft.

The list was about 1/4 degree to starboard. The draft and list after test are substantially the same. Some minor flooding occurred in the stern as the result of leakage through the rudder post.

(b) Structural Damage.

HULL

Damage to the forward superstructure is extensive but relatively insignificant with respect to operation of the vessel. The smokestack is badly damaged. The mainmast is moved forward and to port and the after starboard leg of the tripod is pulled free at the main and second decks. The main deck has suffered a major panel deflection aft of Turret 6 and minor deflections forward of this area of the starboard side.

The hull above the waterline along the starboard side aft is dished generally. The interior structure is generally undamaged except on the second deck aft at about frame 125 where deflection of the main deck has caused considerable damage to structure below.

MACHINERY

The stack was torn away at its base and fell over to port in such a position as to completely block the gas passage from the uptakes. The upper part of the uptakes were distorted by the carrying away of the stack. The port crane was moderately damaged and the starboard crane severely damaged structurally. Deflection of the main deck aft caused severe damage to the after deck winch. One

boat went overboard. Structural damage to decks and bulkheads crushed the butcher shop equipment and caused minor damage to galley equipment.

ELECTRICAL

Electrical damage occurred in areas as indicated below.

1. Both masts.
2. Main deck aft.
3. Second deck aft.
4. Superstructure forward and aft.

(c) Other damage.

HULL

The machinery plant is operable after ship's force repairs. Ship control is operable. Fire control is operable except for radar.

MACHINERY

Boilers 3 and 4 were considerably damaged, #2 lightly damaged. All significant damage to boilers was to casing panels, which were blown out and in some cases ruptured. The after deck winch was severely damaged and is considered to be beyond repair. The port crane was considerably damaged. This damage was largely structural but there was some damage to hydraulic machinery of this unit. The starboard crane rotating platform was thrown off its rollers, platform cracked, and gear crane housing blown off. One motor whaleboat was blown overboard. On the other boat, the muffler exhaust pipe and battery lugs were broken off. The auxiliary exhaust steam line was cracked in two places in the engine room. Butcher shop equipment was demolished. There was minor damage to galley equipment.

ELECTRICAL

Damage to electrical equipment in general was of a minor nature. Operability remained essentially the same as before Test A except those damaged as listed below.

1. Two-36", one -24", and four-12" searchlights.
2. Running and signal lights.
3. After deck winch.
4. Four vent sets.
5. Two master gyro compasses.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation originated at a point bearing about 135 degrees relative. Exposed paint, wood decking and cordage is scorched and blackened. Some paint isblistered. Both horizontal and vertical surfaces are affected. In some places two coats of paint are burned. Blistering is extensive and there is an unusual amount of paint peeling.

MACHINERY

Paint on exposed surfaces was charred and blistered. Otherwise, there is no evidence of heat in machinery spaces or on exposed machinery.

ELECTRICAL

Radiant heat scorched the paint on electrical equipment exposed directly to the blast. Some cables on the foremast were affected to the extent that beads of insulation protruded through the armor.

(b) Fires and Explosions.

HULL

Fires on board were not extensive and did not jeopardize the safety of the vessel. U.S. Army Quartermaster test equipment on the superstructure deck, frames 55 to 68, starboard and 48 to 56, port, burned as the result of direct heat radiation. The equipment consisted of rations, mess kits, battle helmets, blankets, tents, clothing, skis, and similar articles. Fire occurred in every case where equipment packed in waterproof paper covered with sacking was exposed to radiation. Cardboard and wooden boxes similarly exposed, scorched, but did not ignite as did the sacking material. Wood decking burned in way of these fires. A small fire occurred in the boat shop at frame 72, main deck, starboard, where a mattress and internal paintwork burned. The hatch overhead was blown off by the air blast and it is probable that the fire was caused by embers from the burning quartermaster gear entering the hatch.

MACHINERY

There is no evidence of fires or explosions in machinery spaces or on exposed machinery.

ELECTRICAL

Damage by fire to electrical equipment was negligible. One-12" signal searchlight had its portable cable burned by fire on bridge wing.

No explosion occurred.

(c) Shock.

HULL

There are minor evidences of shock. Ready service boxes are lifted off foundations. Cast iron foundations for equipment in the potato peeler room, frame 64, starboard, on the main deck, are fractured

MACHINERY

There is no evidence of shock.

ELECTRICAL

No damage to electrical equipment occurred that can be attributed directly to shock. Electrical damage attributed indirectly to shock at time of structural failures are as follows:

1. The after warping winch control resistance was broken.

2. Portable batteries jumped out of their racks.

3. The overload relay spring for doughmixer popped out of place.

(d) Pressure.

HULL

The air blast wave originated at a point bearing about 135 degrees relative. Flat surfaces are more seriously affected than curved surfaces. The sheer strake on the starboard side aft is dished to a maximum depth of eight inches. The main deck aft of Turret 6 is depressed about two feet. The after fire control tower is moved bodily forward and to port. This caused compressive failures in the forward and port tripod legs and pulled the starboard leg free at the main and second decks. Structure in the tower is essentially intact except that exposed bulwarks are bent inboard and nearly all door frames are distorted. The stack is bent forward and to port and is torn. The foremast structure is generally intact. The range-finder platform on the 05 level at the rear of the foremast has been lifted by air shock, tearing the supporting beams. All sheet metal and expanded metal topside has suffered considerable damage. Exposed sun shields on ready service boxes are bent upward. Flat surfaces of exposed bulkheads and gun tubs are generally dished. Door frames are generally distorted even in shielded locations.

MACHINERY

All major damage to the machinery installation was caused by blast pressure or by deflection of decks and bulkheads which was caused by blast pressure. Minor damage is believed to have been caused by the whipping motion of the ship following the blast. The blast apparently came from slightly aft of the starboard beam.

ELECTRICAL

The blast pressure wave came from about 125° relative. Electrical damage attributed to pressures are as follows:

1. The after warping winch made inoperable when deck support gave way.

2. Searchlights except three-12" signal lights on the port wing of the bridge are damaged and inoperable.

3. Some cables were damaged by structural failure.

4. The vertical fighting lights, running lights and anchor light were inoperable due to structural failures flying object and open circuits.

5. Ventilating motor impellers were bent due to pressure impeller housings.

(e) Any effects apprently peculiar to the Atom Bomb.

HULL

Aside from radioactivity, the application of heat and high pressure over large areas is an effect peculiar to the Atomic Bomb.

MACHINERY

A blast pressure of this magnitude is believed to be peculiar to the Atom Bomb.

ELECTRICAL

No effects to electrical equipment peculiar to the bomb occurred.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

HULL

Propulsion was temporarily lost but is now in operation using a jury stack. Ship control is operable.

MACHINERY

All steam power was lost. The after deck winch and butcher shop equipment are beyond repair. The cranes require major repairs, although emergency repairs to the port crane to make it temporarily operable could be made by the ship's force. The engine of the one remaining motor whaleboat could be repaired by the ship's force if spare parts were available. All other damage to machinery is minor and could be easily repaired by the ship's force. It is estimated that the ship's force require at least 4 days to make temporary repairs to enable the ship to steam at slow speed. It is estimated that approximately 45 working days at a shipyard would be required to restore the ship to normal operating conditions. The effect on ship control from a machinery viewpoint was to limit power to that furnished by the two (100 kw) emergency diesel generators.

ELECTRICAL

Effect on electrical equipment was negligible. Ship control was not affected, emergency diesel generators were both operable. With the return of steam the main turbo-generator was operable. Both master gyros were operable on replacing mercury that had spilled.

(b) Effect on gunnery and fire control.

HULL

Gunnery and fire control are operable except for radar.

MACHINERY

No comment.

ELECTRICAL

1. Effect of electrical damage to gunnery was negligible.

2. Effect of electrical damage to fire control was negligible.

(c) Effect on watertight integrity and stability.

HULL

Watertight integrity is only slightly affected. Stability is not affected.

MACHINERY

No comment.

ELECTRICAL

Electrical equipment had no effect.

(d) Effect on personnel and habitability.

HULL

Topside personnel would have incurred casualties from radiation, heat, and air blast. Some casualties would have occurred below decks from shock and the deformation of the main deck, aft.

Habitability would have been seriously reduced on the second deck between frames 120 and 130. The remainder of the vessel is in good condition.

MACHINERY

It is estimated that there would have been a high percentage of casualties in the afer fireroom and some casualties in the forward fireroom if the ship had been steaming at the time of the test. It is not believed that there would have been any other personnel casualties below decks, although casualties among exposed personnel would have been high. Habitability is reduced by loss of steam power, and to a minor extent by damage to galley and butcher shop equipment.

ELECTRICAL

Electrical effect was negligible. Confined entirely to damage to ventilation such as impeller housings.

(e) Total effect on fighting efficiency.

HULL

The vessel would have been immobilized for several hours. Electronic equipment is inoperable. Topside personnel would have been incapable of functioning for some time.

MACHINERY

The ship is immobilized and is no longer an effective fighting unit. It is estimated that 45 working days at a shipyard would be required to restore her machinery to normal condition.

ELECTRICAL

Electrical effect on fighting efficiency would have been negligible.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Personnel and main machinery installations are most seriously affected. Masts and tower structures proved inadequate against the attack. Except for topside personnel casualties and damage to stacks, uptakes, and boilers, this ship would have been able to keep at sea as a fighting unit with reduced efficiency because of the loss of the radar.

MACHINERY

It is not believed that a modern battleship, exposed to a similar attack at the range of the ARKANSAS would have been immobilized, although some damage to boilers would probably have occurred. The stacks of the ARKANSAS would probably not have carried away if it had been in good condition, although it would undoubtedly have been damaged. The ARKANSAS's stack was severely corroded before Test A.

ELECTRICAL

1. No electrical damage to ship's service generating plant occurred.

2. Interior communications had slight disruption mainly on distorted superstructures.

3. Electrical damage to ventilation was negligible.

4. Searchlights received the major part of electrical damage.

5. In general electrical damage had no major effect on this ship.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

Methods should be developed to protect boiler installations from blast damage. All topside personnel, especially those in gunnery and fire control stations should be protected.

Personnel in 12 inch turrets were unhurt but the commanding Officer estimates that 80% of all other gunnery and fire control personnel would be casualties. In general, superstructure should be strengthened and faired with all overhangs eliminated.

MACHINERY

Stacks and boiler casings should be made more resistant to blast pressure.

Steps should be taken to insure that stacks of all vessels are inspected and repaired as required to preserve their original strength.

ELECTRICAL

Specific recommendations are given in part C for each item where applicable.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

Damage is limited to dishing of light structures topside. The bulkheads of the captain's sea cabin are dished about two inches. Light metal doors on two rangefinders are dished. The starboard after flag bag and life net stowage at frame 100 are displaced to the main deck. Minor distortions are evident in light deck lockers and ventilation openings.

MACHINERY

The light metal skirting around the base of the stack was pushed in slightly. The stack itself was not damaged.

ELECTRICAL

Not observed.

(c) Other damage.

HULL

Not observed.

MACHINERY

The casings of boilers 1, 2, and 5 were slightly wrinkled. The casings of boilers 3 and 4 were bulged outward and opened slightly at the joints. There is no other damage to machinery, all of which has been operated since Test A.

ELECTRICAL

Damage to electrical material was confined to minor derangements of searchlights and the burning of a small amount of unimportant cable.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation came from about 150 degrees relative. Paint blistering and scorching is relatively slight and confined to vertical surfaces. White paint is undamaged. Exposed lines and cordage are scorched.

MACHINERY

Paint on the exposed side of deck machinery was scorched and blistered.

ELECTRICAL

Radiant heat emanating from the blast, caused slight scorching of paint on some exposed electrical equipment and caused minor scorching of cable.

(b) Fires and Explosions.

HULL

Two minor fires were ignited. Heat radiation caused a

small fire in torn canvas covering the kapok padding on two aircraft recovery sleds stowed on bulkhead 73 at the superstructure deck level. The second fire burned flags in the port flag bags and Army Test Gear on the deck below. The cause of this fire is indeterminat. There were no explosions.

MACHINERY

No evidence.

ELECTRICAL

A fire on the superstructure deck at frame 54 port side burned cable and local boxes on the overhead beneath. A second fire aft of the secondary control station burned a small amount of cable on the tower.

There were no explosions on the ship.

(c) Shock.

HULL

There is no evidence of shock.

MACHINERY

No evidence.

ELECTRICAL

The only evidence of shock found in electrical equipment was the loss of lead chafing pads under the mirror hold down clips on both 36" searchlights, and the breaking of the dome glass and damage to shutter on the port 36" light. The breakage may have been missile damage or pressure damage.

(d) Pressure.

HULL

The air blast originated at a point bearing about 150 degrees relative. Damage is slight and is limited to dishing of light superstructure bulkheads, sheet metal flag bags and lockers, and other light damage. The weather bulkhead around the stack below the skirt is dished on all four sides.

MACHINERY

Blast pressure entered the boilers via the stack and uptakes and caused minor damage to the casings of boilers 3 and 4, and negligible distortion of the casings of boilers 1, 2, and 6.

ELECTRICAL

The breaking of the 36" dome glass, possibly by blast pressure, is the only evidence of pressure found in any electrical equipment.

(e) Effects peculiar to the Atomic Bomb.

HULL

None.

MACHINERY

A blast pressure of sufficient magnitude to cause any damage at this distance from an explosion is apparently peculiar to the Atom Bomb.

ELECTRICAL

The scorching of cable and paint by radiant heat was the only effect peculiar to the Atom Bomb.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

HULL

Not observed.

MACHINERY

The casings of boilers 3 and 4 were opened sufficiently to require securing these boilers for repairs. It is estimated that the ship's force could have made repairs to these boilers, to enable them to be steamed, within 2 hours. No other damage has any effect on operation.

ELECTRICAL

None due to electrical damage.

(b) Effect on gunnery and fire control.

HULL

Not observed.

MACHINERY

No comment.

ELECTRICAL

None due to electrical damage.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None resulting from electrical system failures.

(d) Effect on personnel and habitability.

HULL

The habitability of the vessel is unimpaired as a result of Test A. Some topside personnel would have been injured.

MACHINERY

There might have been a few casualties among personnel of No. 2 fireroom if the ship had been operating at the time of the test. No other casualties would have taken place among personnel below decks. Habitability was not affected.

ELECTRICAL

There was no reduction in habitability, nor would there have been any effect on personnel resulting from electrical damage.

(e) Effect on fighting efficiency.

HULL

Except for some personnel casualties, fighting efficiency would be unaffected.

MACHINERY

The ship's maximum speed would have been reduced to about 18 knots for a few hours.

ELECTRICAL

The very minor electrical damage would not have reduced fighting efficiency.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Damage is superficial and did not affect the fighting efficiency of the vessel.

MACHINERY

It is not believed that the boilers of a modern battleship would have been affected at the range of the NEW YORK from this form of attack.

ELECTRICAL

Primary bomb damage to electrical equipment on the vessel was negligible. Secondary damage due to fires was minor and would not have occurred if damage control parties had been aboard.

V. Any Preliminary General or Specific Recommendations.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

No recommendations are made.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The draft readings taken just prior to, and immediately after the test are as follows:

	Forward	Aft	Mean	List
Before Test -	28' 0"	31' 0"	29' 6"	0 Degrees
After Test -	28' 0"	31' 0"	29' 6"	0 Degrees

Some seepage through the shell into four after voids in way of the skeg has occurred, but there was not enough water taken on to change the trim or draft.

(b) Structural damage.

HULL

Superstructure - The sides and after face of the superstructure are mildly dished, showing the almost undirectional effect of the blast. The critical plate weight appears to be about ten pounds, with an additional advantage in strength being indicated for curved surfaces rather than flat panel areas of identical weight.

Light operational gear exposed to the blast such as antennae poles, radar screens, flag bags, and searchlights are carried away. Both topmasts are down. Handrails and light bulwarks are intact but damaged, and overhanging structure on the port side is deflected upwards a small amount.

The upper deck, forward of the superstructure, is deflected between transverse bulkheads. Maximum deflections of four to six inches appear to starboard alongside of No. 1 turret. The deck beams

and supporting structure conform to the deflection of the deck and the deck beams are distorted in way of their connections to bulkheads and shell stiffeners. Stanchions and light bulkheads on the main and second decks, immediately below, are buckled slightly (See figure 1).

A rectangular section of the main deck, extending longitudinally between frames 86 and 91, port side, failed in two places. The longitudinal failure lines were 29 feet off the centerline and 13 feet off the centerline through a single riveted seam. The opening is approximately 20 feet long by 16 feet wide and is in way of machinery access plate. The failure appears to be attributable, primarily, to a lack of supporting stanchions.

There is heavy deflection of the main deck aft as a result of blast. The most severe depression is slightly aft of No. 4 turret (Figures 1 and 2). This depression pulled the deck away from the after face of No. 4 barbette. The maximum deflection in this area is about 16 1/2 inches. Between frames 122 and 132 the maximum deflection is about 14 inches. The deflections of the main deck are accompanied by failure of supporting stanchions and distortion of connections of the deck beams to the shell stiffeners. The second deck is deflected aft of the armor from bulkhead 122 to about frame 134, the maximum being about 12 inches. The damage diminishes as it goes deeper into the ship.

The plane handling crane on the stern is collapsed. The catapult foundation is tilted forward as a result of the deck deflection.

The interior space under the failure in the port side of the main deck, frames 85 to 96, is heavily damaged by blast. There is evidence of mild shock in the second deck spaces aft of No. 4 barbette, such as failure of cast iron motor foundations, separation of covers in ventilation ducts, and failure of piping support brackets in way of their welded connection to the overhead.

Below the armored second deck there appears to be no structural damage, except that resulting from a mild blast wave conducted through the ventilation systems. This is confined almost

entirely to the firerooms, where the boiler casings were ruptured.

The shell above the waterline is intact and appears to be in good condition, except for some panel dishing on the port and starboard quarter.

The exterior paint exposed to the blast is generally scorched and blistered through about one coat.

The only damage to the underwater body appears to be the seepage of water through the shell into four voids near the skeg.

MACHINERY

The outer casing of the stack was torn away at its base on the port side. The stack was dished in, especially on the port side, and was crushed in at the top. The inner casing of the stack and the upper part of the uptakes were badly crushed. Deflection of decks and bulkheads, especially collapse of the main deck soft patch, caused considerable damage to piping. Ventilation ducts to both enginerooms were severely damaged. The crane boom was twisted at its base and bent over to starboard but the crane machinery is operable.

ELECTRICAL

In the areas of structural damage the adjacent or attached electrical equipment was damaged by deformation of the supporting structure or by being struck by missiles. This occurred in the mast structures, on the second deck at frames 86 to 91 port, and aft of frame 126, port and starboard.

(c) Other Damage: Machinery, electrical, ship control, fire-control, gunnery, electronics.

HULL

The airplane crane training gear is inoperable. All boilers are out of commission, and the ventilation system of the port engine room is not functioning. The whistle and siren are demolished.

Electrical cables running through the burned areas of the upper deck, frames 70 to 85, are burned.

Fire control has been reduced to some extent due to damage to the director and the loss of all fire control and search radar antennae.

The C.I.C. and all transmitting and receiving radio and electronic equipment is reported as undamaged, except for the loss of all exposed antennae.

MACHINERY

All boiler casings failed, brickwork was moderately damaged. Damage to the stack partially closed the gas passages from the boilers. All forced draft blower suction flaps were bent and jammed closed. There was considerable local damage to piping, mostly caused by failure of deflection of supporting structures. The whistle and siren were knocked off and demolished. The crane was damaged structurally.

ELECTRICAL

The following electrical equipment received damage during this test:

1. Searchlights.
2. Running anchor and signal lights.
3. Magnesyn, and magnetic compasses.
4. Gyro repeaters and alidades.
5. Topside announcing system reproducers.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

The blast center appears to be about 210 degrees rela-

tive and at an approximate elevation of 45 degrees. The heat effect is not severe. Although on exposed surfaces, scorching is extensive, blistering is only moderate and extends not more than one coat down in 95% of the area affected. Nowhere does there appear to be more than two coats affected.

The wood covered weather decks are superficially scorched. Shell plating is scorched only on those surfaces facing the blast which composes practically all of the port side, stern, and a few frames of the starboard quarter. All exposed topside surfaces facing the blast are also scorched. In a few areas the scorching is heavier than average and nearby indirectly exposed surfaces are lightly scorched.

It is noted that the paint, covering wooden surfaces, is more heavily scorched than that covering steel surfaces under similar circumstances.

MACHINERY

Paint on exposed machinery was scorched and blistered. Otherwise there was no evidence of heat on machinery spaces.

ELECTRICAL

Radiant heat of the blast singed the topmast layers of paint on cables, wireways, and electrical equipment directly exposed to it, but failed to affect their electrical properties.

Several fires in Army Quartermaster supplies exposed on the 02 deck between frames 71 and 86 port and starboard burned through the wooden deck and overheated the cables in wireways on the 01 deck directly beneath it. The heat was sufficient to burn out a number of these cables which caused a loss of power to galley equipment.

(b) Fires and Explosions.

HULL

The bulkheads and overhead structures in the steam table space A-0114-L, frames 70 to 84, upper deck level and adjoining spaces are blackened, apparently as a result of ignition of grease in the galley ventilation system, due to the intense fire in U.S. Army Quartermaster gear stowed on the open deck above.

Several holes are burned in the teak wood cover of the upper deck forward of No. 2 turret. It is reported that small pieces of canvas and metal grommets were found within the burned areas. It is believed, therefore, that these fires were caused by the burning of a new, unpainted, canvas wind breaker on the forecastle which was ignited by direct heat radiation (figure 1).

Aft, on the starboard side, a three square foot section of the main deck cover at frame 144 is burned away. It is believed that this fire was a result of the ignition of a coiled 1/2 inch manila line by radiated heat.

The only large fire on board occurred in U.S. Army gear placed on the exposed superstructure deck between frames 70 and 80. Individual fires breaking out in packed army clothing and subsistence rations, port and starboard, nearly destroyed all of this equipment. Material stowed along the centerline, afforded protection from the effect of direct radiation by the after superstructure, is relatively undamaged. Some canned and boxed food evidently exploded, many cans and sections of boxed rations being over fifty feet away from their original positions. It is believed that ignition of these items was caused by radiated heat that penetrated into crevasses formed by the closely packed bales to a depth where the following air blast could not reduce the surface temperature below the kindling point by convection.

MACHINERY

Not evidenced.

ELECTRICAL

Fires in extremely combustible Army material exposed on the boat deck damaged lighting and power cables in the overhead of the compartment below, and destroyed phenolic type lighting fixtures, and connection boxes which were located in such a way as to receive

conducted heat through the overhead.

No evidence of explosions was noted.

(c) Shock.

HULL

There is practically no evidence of shock damage. On the second deck aft, below the depressed area of the weather deck, two cast iron intake blower motor housings have failed. Hangar straps are also broken loose from the overhead in a few instances. On these cases it is possible that the effect of the blast was transmitted rapidly to the immediate vicinity of these items through heavy stanchions added to support equipment stowed top-side.

MACHINERY

Some breakage of small piping was probably caused by shock. Leads left in the bearings of the port low pressure turbine indicate motion of the turbine journals not exceeding .007 inches.

ELECTRICAL

Although subjected to a large amount of pressure, very little acceleration was imparted to this vessel. Accordingly, there was little evidence of shock damage to electrical equipment on this vessel.

(d) Pressure.

HULL

All of the structural damage is considered to be a result of air blast. There is some evidence of "focusing" of the blast in athwartship passages in the superstructure. Topside compartments that were closed off show light panel dishing on all outer surfaces, apparently as a result of increased outside air pressure. The light outer casing of the stack is severely distorted. Doors and door frames show

considerable weakness where they are exposed to the blast. The weather deck is generally depressed, the after portion being dangerously weakened. The critical plate weight appears to be about ten pounds at this range.

The behavior of structure, which in this particular vessel is mostly outmoded (figures 4, 5, and 6), is of significance only to the extent that although directly exposed positions held up suprisingly well, and overall increase in designed strength of topside structure and the weather decks is necessary.

MACHINERY

Blast pressure caused nearly all damage to the machinery installation, either by its direct effect or by deflecting decks and bulkheads which in turn damaged piping, etc. This includes damage to the stack, boilers, crane, ventilation ducts and forced draft blower flaps. The pressure wave apparently came from near the port quarter.

ELECTRICAL

Blast pressure accounted for most of the damage to electrical equipment mounted topside. Starboard 36" searchlight was completely demolished by the blast, and the resulting fall to the boat deck. The port 36" searchlight was badly bent and its stand was torn from its foundations by the blast pressure. This damage resulted from failure of cast aluminum construction. Other evidence of damage by blast pressure was noted in the damage to alidades, announcing system reproducers, and other electrical equipment located in exposed places on the topside of this vessel.

(e) Effects peculiar to the Atom Bomb.

HULL

Subjection of the ship, almost simultaneously, first to rather intense radiated heat and then to high structural loading by air blast throughout the entire length of the ship are the only effects peculiar to the atomic bomb.

MACHINERY

A blast pressure of this magnitude at the range of the NEVADA from the explosion is apparently peculiar to the Atom Bomb.

ELECTRICAL

A radiant heat flash, quickly followed by an extremely powerful, and relatively slow acting blast wave are characteristic of this weapon.

III. Results of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

Propulsion was lost temporarily due to damage to boilers. Damage to considerable electronic gear is associated with the failure of topmasts, yardarms, and light superstructure plating.

MACHINERY

All steam power was lost by damage to boilers and stacks. Damage to ventilation ducts would have made the port engine room and possibly the starboard engine room untenable. It is estimated that temporary repairs to boilers and ventilation ducts to enable the ship to steam at slow speed could have been made by the ship's force within 48 hours. It is estimated that approximately 20 day's work at a shipyard would be required to restore the machinery installation to normal operation. The crane is inoperable because of structural damage. Damage to piping was of purely local significance and would have had little, if any, effect on any important system. Except for reduction of power available, the test had little effect on ship control as far as machinery is concerned.

ELECTRICAL

There was no effect on propulsion and electrical ship control equipment as a result of electrical damage to this vessel.

(b) Effect on gunnery and fire control.

HULL

Although there is little damage to exposed gun mounts, it is quite evident that the present bulwarks and splinter shields do not offer any appreciable protection from this type of weapon. However, completely enclosed mounts, even of relatively light weight, are undamaged and in good condition.

MACHINERY

No comment.

ELECTRICAL

There was only minor damage to gunnery or fire control circuits, except the damage to cables in the galley area by heat from fires on the deck above, which put the AA directors in that area out of commission.

(c) Effect on watertight integrity and stability.

HULL

There is no appreciable effect on stability. The watertight integrity is impaired above the second deck aft, of the bulkhead 115, by the separation of the weather deck from the after face of No. 4 barbette, and above the third deck, aft of bulkhead 122, by the centerline separation in the second deck resulting from the punching action of misaligned stanchions. There is also a large hole in the main deck, portside just aft of the break in the weather deck which has exposed the second deck between bulkheads 85 and 97.

MACHINERY

No comment.

ELECTRICAL

Damage to electrical equipment did not affect watertight integrity or stability.

(d) Effect on personnel and habitability.

HULL

It is evident that the casualty rate among exposed personnel would have been heavy. There is a slight reduction of habitability in crew's spaces on the second deck between bulkheads 85 and 97, and aft of bulkhead 115. The bakery and galley were unusable for a short period due to electrical failures and minor damage caused by fire in way of these spaces.

MACHINERY

It is estimated that casualties among fireroom personnel would have been high if the boilers had been steaming. It is not believed that there would have been any other casualties among personnel below decks.

ELECTRICAL

Damage to the galley area reduced the habitability for a period of about 3 days, until emergency circuits could be run to the bake shop and galley equipment. Ventilation sets suffered minor damage. No other electrical damage had any effect on the habitability of the vessel.

(e) Total effect on fighting efficiency.

HULL

The strength of the hull girder is but slightly impaired. The greatest effect on fighting efficiency, is the loss of power through damage to all boilers and the destruction of all electronic antennae, incident to the failure of masts. The amount of reduction in efficiency due to the high casualty rate among specially trained personnel because of inadequate protection from radiation and air shock, although unpredictable, appears to be of significance.

MACHINERY

The ship was temporarily immobilized. She could probably have been gotten underway at slow speed within 48 hours.

ELECTRICAL

The electrical damage reduced the fighting efficiency only by the loss of searchlights, certain fire control equipment, and reduction of telephone communications to the heavy machine gun control amidships.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Although the ship is in sound condition, structurally, protection against radiation and blast is inadequate. The destruction of masts supporting fire control, communications antennae, and venting of the blast into firerooms through the stack would have left the ship dead in the water and without adequate means of communication. Considering the time required to rig emergency repairs, this damage is believed to be critical.

MACHINERY

It is not believed that boilers of a modern battleship would have been damaged severely enough by this test to immobilize the vessel. Damage to the stack of a modern battleship would probably have caused some reduction in steaming capacity.

ELECTRICAL

Electrical damage to this vessel resulted from the effects of blast on masts, superstructure, and the main deck. This involved searchlights, fire control and communication equipment topside; vent blowers on the second deck; and cable runs in the galley area, and pinched or broken cable runs in the vicinity of structural damage in the maindeck aft of frame 90. No electrical damage occurred within the

armored box of the hull. Some of the blast damage would have been eliminated by the changes in design which has already been made in modern equipment. Cast aluminum bases, stands and searchlights, pelorus stands, and similar equipment were particularly susceptible to the damage by blast pressure, and provided examples of obsolete design which now have been proved to be inadequate. The damage by fire would have been almost entirely eliminated if fire fighters had been present. Elimination of all readily combustible material from topside exposure would have undoubtedly prevented most, if not all, of the fires.

V. Preliminary Recommendations.

HULL

The camber of weather decks should be increased. End connections of stanchions should be designed to allow the columns to buckle at their critical load without tripping the flange of the deck beams which they support. Additional recommendations pertinent to topside structure are listed in Part C, Item B, subitem (e), of this report.

MACHINERY

(a) Stacks and boiler casings should be made more resistant to blast pressure.

(b) Ventilation systems to vital spaces, such as engine rooms, should be located so they will not be exposed to the direct effects of blast pressure.

ELECTRICAL

From the damage sustained by the topside of this vessel, it is recommended that consideration be given to the elimination of the 36" searchlights on this type of vessel, since these searchlights are no longer used as originally intended; i.e., in conjunction with fire control. In the event these lights must be retained, it is recommended that the use of cast aluminum equipment be completely avoided. The searchlight yoke should be strengthened considerably and made from fabricated

steel. Castings should be avoided. Until such a time as a substitute for visual signalling can be provided, it is recommended that the 24" signalling searchlights be remotely positioned and controlled, in order that operating personnel may be in a protected location. It is assumed that signalling with short range signalling devices such as 12" signalling searchlights would be done from protected areas in the superstructure.

It is recommended that the exposed electrical equipment on this vessel be reduced as much as possible to insure maximum protection against the heat and blast of the atomic bomb. If this equipment must be exposed, it should be adequately covered with non-flammable enamel to insure protection against the heat of the blast.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts; list, general areas of flooding, sources.

There is no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

The light bulkheads in the after side of the foremast superstructure area, in general, are slightly dished. This is particularly true in confined passageways such as between frames 86 and 87 on the upper deck where the peripheral bulkheads are dished about two inches.

A vent intake duct at frame 80, port, which extends from the superstructure deck to the second deck, is bulged through out its length. The plating of smaller branches from this duct has been torn in several places.

Mushroom vent intakes at frame 60 on the upper deck are distorted.

MACHINERY

The stack was slightly dented and its outer casing pushed away about 1/8 inch from the main deck, port side. This does not impair operation.

ELECTRICAL

There was minor structural damage on topside, particularly in the vicinity of the galley and after side of bridge structure. This damage had little if any effect on electrical equipment.

(c) Other damage.

HULL

Operability of machinery, electrical equipment and ship control gear, including navigational equipment, is unimpaired.

Fire control equipment is operable except for the Mk. 14 sights and where damaged by heat from a fire in U. S. Army Quartermaster gear.

Gunnery equipment has not been affected.

The IFF is inoperable because the antennae are damaged. The Mk. 22 is out of commission because electrical wiring has been damaged by an adjacent fire. Other electronic equipment is operable.

MACHINERY

The casing panels of boilers 1, 5 and 6 are bulged and pulled apart at joints. Casing panels of boilers 2, 3 and 4 are slightly bulged. The two forward fresh water pumps were jarred out of alignment.

ELECTRICAL

1. Damage to electrical machinery and electrical elements of ship control, fire control and gunnery as a direct result of the bomb was negligible.

2. Cables to Mk. 57 gun director and Mk. 29 fire control radar located on port superstructure deck and 24 inch searchlight received secondary damage due to fire in Army Quartermaster gear displayed in this area for test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

A directional flash heat radiating from about 220 degrees relative, scorched and blistered exposed paint. Two thicknesses of paint have been affected. In one place paint has been scorched by reflected heat. There is only slight scorching of decks and other horizontal surfaces.

Exposed signal halyards and life raft lines are scorched. Jute fenders on a U. S. Army amphibious truck at frame 40, port, appeared to be the most vulnerable type of cordage onboard.

MACHINERY

No evidence, except for scorched and blistered paint on exposed side of deck machinery.

ELECTRICAL

Radiant heat coming from 200° to 205° relative, blistered the paint on all exposed electrical cables and equipment located on the port and after side of superstructure. Other than damage to paint there was no adverse effect on this equipment.

(b) Fires and explosions.

HULL

The major fire started in the U. S. Army Quartermaster equipment stacked on wooden pallets between frames 60 and 80 on the port side of the superstructure deck. This equipment consisted of various types of clothing, mess, and outing equipment. This was provided with the standard quartermaster wrapping of waterproof paper and burlap. The debris from the fire has been disarranged by water

from the fire hose so that the point of original ignition cannot be determined, but it broke out about three hours after the burst. It was apparently intensified by the explosion of cans of methyl bromide, D.D.T., and aerosol. The fire spread to life rafts and cork float nets in the vicinity. Considerable damage was done to the wooden deck covering, but the steel deck is undamaged.

MACHINERY

No evidence.

ELECTRICAL

1. A fire originating in Army quartermaster gear displayed on port side of boat deck damaged cables to Mk. 57 gun director, Mk. 29 fire control radar and 24" searchlight.

2. There were no explosions except for one case of small cans of Methyl Bromide and two 5 gallon drums of insect spray in Army quartermaster gear, which caused no damage other than to intensify the fire.

(c) Shock.

HULL

There is no evidence of any damage resulting from shock.

MACHINERY

No evidence.

ELECTRICAL

There was some evidence of shock throughout the vessel. However, except for two fresh water pumps jarred out of alignment and a few lamps broken, electrical equipment was unaffected.

(d) Pressure.

HULL

Blast pressure from the same direction as the radiant flash heat is evidenced by the dishing of flat light metal bulkheads. Wherever the blast entered a pocket between bulkheads, the damage is more severe.

One empty locker on the superstructure deck is blown apart, apparently from internal pressure. This probably happened during rarifaction wave following the pressure wave.

Pressure caused distortion of all six boiler casings in varying degrees. Those with closed registers suffered somewhat greater damage than the two with open registers.

MACHINERY

Blast pressure caused all damage to the machinery installation except the misalignment of the forward fresh water pumps. This was apparently caused by whipping motion of the ship following the blast. The blast apparently came from near the port beam.

ELECTRICAL

This vessel was subjected to a pressure wave coming from 200° to 205° relative which caused minor structural damage, but had no appreciable effect on any electrical equipment. Slight distortion of a few cast aluminum enclosures, minor damage to starboard 24" searchlight and bending of the direction rod on wind direction and wind intensity transmitter, were the only effects on electrical equipment due to pressure.

(e) Any effects apparently peculiar to the atom bomb.

HULL

Effects peculiar to the atom bomb are the long range of the blast, flash heat effects, and the spotty effects of the flash heat.

MACHINERY

A blast pressure sufficient to cause damage at this distance from an explosion is apparently peculiar to the atom bomb.

ELECTRICAL

Radiant heat and heavy blast pressure were the effects noted apparently peculiar to the atom bomb.

III. Effects of damage.

(a) Effects on machinery, electrical, and ship control.

HULL

There is no effect on propulsion or ship control. There may have been some temporary adverse personnel effects from the jarring loose of excess dust and dirt.

MACHINERY

Boilers 1, 5 and 6 were made temporarily inoperable by damage to their casings. Repairs could have been made by the ship's force within a few hours. No other damage had any appreciable effect on operability of machinery. Ship control was not affected.

ELECTRICAL

The overall electrical installation suffered only negligible damage, all of which is within the capacity of the ship's force to repair in a relatively short time. Propulsion and ship control were unaffected from an electrical viewpoint.

(b) Effect on gunnery and fire control.

HULL

The operation of exposed gunnery and fire control stations would have been impaired by personnel casualties. The only material damage is to sights on 40mm directors and 20mm mounts.

MACHINERY

No comment.

ELECTRICAL

1. There was no electrical damage as a direct result of the bomb which had any adverse effects on gunnery or fire control.

2. Secondary damage due to fire in Army quartermaster gear did render the Mk. 29 fire control radar and Mk. 57 gun director on port superstructure inoperable.

(c) Effect on watertight integrity and stability.

HULL

There is no effect on the watertight integrity or stability.

MACHINERY

No comment.

ELECTRICAL

Electrical damage had no adverse effects on watertight integrity and stability.

(d) Effect on personnel and habitability.

HULL

There would have been some personnel casualties in exposed stations if the crew had been at general quarters.

The habitability of the ship is unimpaired.

MACHINERY

There would probably have been some personnel casualties among fireroom personnel if the ship had been steaming at the time of the test. Otherwise, it is not believed that personnel below decks would have been affected by the test. The test had no effect on habitability.

ELECTRICAL

1. Probable personnel casualties are estimated to be heavy in all exposed stations on topside, particularly on port side areas. Flash burns, blast damage and radiation sickness would be the principal causes of the casualties.

2. Habitability has not been impaired as a result of any electrical damage.

(e) Total effect on fighting efficiency.

HULL

The fighting efficiency of the ship would have been temporarily impaired by topside personnel casualties and by damage to sights on 40mm directors and 20mm mounts.

MACHINERY

Boiler power would have been reduced by about 50% and maximum speed to about 16 knots temporarily. The damaged boilers

could have been repaired by the ship's force within a few hours, after which full boiler power would be available. The test had no other effect on fighting efficiency, as far as machinery is concerned.

ELECTRICAL

Electrical damage directly attributable to the atom bomb had practically no effect on the fighting efficiency of this vessel.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Aside from the possible effects of radioactivity, damage is of a minor nature.

MACHINERY

The PENNSYLVANIA was apparently near the limiting range of serious damage to a vessel of her class. It is not believed that boilers of a modern battleship would have been damaged sufficiently to impair operability at the range at which the PENNSYLVANIA was exposed in Test A.

ELECTRICAL

This vessel was subjected to a flash of radiant heat which started fires in combustible materials, followed by an air blast pressure of sufficient magnitude to distort boiler casings, deflect light steel bulkheads and dish doors in topside structure. However, this damage was not severe enough to cause any appreciable change in the electrical installation except for the secondary damage to electric cable due to fire in Army quartermaster gear displayed on port side of boat deck for test.

V. Preliminary Recommendations.

HULL

Topside structure requires redesign, if material and personnel casualties are to be held to an acceptable level. Air lances should be used periodically to insure removal of dirt and dust from inaccessible locations. Cleaning of the ventilation system should be mandatory during every Navy Yard overhaul.

MACHINERY

Boiler casings should be made more resistant to blast pressure.

ELECTRICAL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

	Forward	Aft	List
Before test drafts.	32'-5"	34'-7"	1/2° starboard
After test drafts.	33'-5"	36'-1"	0°

Flooding occurred in three fuel oil tanks probably through leaky Kingston valves and in the shaft alley and engine rooms through the stern tubes.

(b) Structural damage.

HULL

Structural damage is confined to light plating in the superstructure and on the main and second decks. The main hull is undamaged. Many light non-watertight doors were torn off their hinges.

MACHINERY

No comment.

ELECTRICAL

Not observed.

(c) Other damage.

HULL

Not observed.

MACHINERY

Two ventilation blowers topside were jammed. The other machinery on this vessel was undamaged by Test A. Most all that was operable before the test has been operated since the test.

ELECTRICAL

There was no significant electrical damage to this vessel. Minor damage was sustained by the 24" searchlights, running and anchor lights, and one announcing system reproducer.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

A heat wave, originating on a bearing of approximately 210 degrees relative, scorched port side paintwork and started several small fires.

MACHINERY

Paint on the exposed side of deck machinery was scorched and blistered.

ELECTRICAL

There was evidence of heat on exposed electric cables. Direction of heat blast was from port quarter. Several fires started onboard and paint was scorched on electric cables on topside. No damage to any electrical equipment from heat.

(b) Fires and explosions.

HULL

Small fires which were started in pine wood decking and in life rafts, occurred on the port weather decks and the forecastle. No explosions occurred.

MACHINERY

No evidence.

ELECTRICAL

There were no fires or explosions in the way of electrical equipment.

(c) Shock.

HULL

There are no significant results from shock. Cast ladder rungs were broken.

MACHINERY

No evidence.

ELECTRICAL

The only evidence of shock damage to electrical equipment was the breaking of the 24" signal searchlight incandescent lamps.

(d) Pressure.

HULL

A pressure wave originated on a relative bearing of 210 degrees. This wave caused slight damage to topside structure

such as light metal bulkheads, castings, and equipment mounted on light foundations. 10 pound plate generally resisted the blast satisfactorily. The main deck aft of Turret 4 was permanently deflected downward one inch.

MACHINERY

Blast pressure jammed two ventilation blowers topside.

ELECTRICAL

There was evidence of pressure as one 1 MC loud speaker on the quarter deck aft was torn from its mounting and blown overboard, and bow and stern lights were blown overboard. Direction of the pressure blast was from the port quarter.

(e) Effects peculiar to the Atomic Bomb.

HULL

The sudden, complete exposure to heat, blast pressure and radioactivity, for all practical purposes, simultaneously, is peculiar to the atomic bomb.

MACHINERY

None.

ELECTRICAL

The effects that were noted as to heat and pressure are peculiar to the atom bomb.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

HULL

There are no known ill effects on machinery or electrical installations other than the antennae damage. All equipment and circuits that operated prior to the test functioned satisfactorily after the test. Flooding that occurred in the shaft alleys and engine rooms did not injure equipment. Ship control, other than damage to antennae and visual signalling gear, is unaffected.

MACHINERY

None.

ELECTRICAL

There was no damage to electrical, machinery, or ship control equipment.

(b) Effect on gunnery and fire control.

HULL

The vessel could have kept fighting at her maximum speed and main battery fire power except for reduction in accuracy due to the use of local control.

MACHINERY

No comment.

ELECTRICAL

No effect on gunnery or fire control.

(c) Effect on watertight integrity and stability.

HULL

Three fuel oil tanks flooded, two on the port quarter and one on the starboard side amidships. The three engine rooms

flooded to above the lower floor plates. Three of the shaft alleys were partially flooded. Other than this above flooding there was no known impairment of the watertight integrity. Stability was affected slightly and probably increased in that the added water was low in the ship.

MACHINERY

No comment.

ELECTRICAL

No effect on watertight integrity or stability from electrical damage.

(d) Effect on personnel and habitability.

HULL

Personnel exposed topside probably would have suffered from heat, blast, and radioactivity. Personnel in the engine spaces would probably have suffered from blast. These spaces have very large ventilation ducts leading almost directly to the weather deck. Habitability of spaces where completely enclosed by structure is unaffected. Habitability of the ship is reduced by the destruction of temporary refrigeration equipment installed on the weather deck which was the only stowage of perishable goods.

On each of the first four days after the test some of the ship's rats were found dead. Others were very sluggish and some were as active as before. The dead rats were found primarily on the main and 01 decks but one was found on the second deck. This indicates possible casualties to personnel in enclosed spaces.

MACHINERY

None below decks.

ELECTRICAL

There was no effect on habitability from electrical damage.

(e) Effect on fighting efficiency.

HULL

Probably the only effects on fighting efficiency would have been the results of injury to personnel. The overall poor condition of the ship and her equipment is due to the lack of preventive maintenance and overhaul and to the fact that her engineering plant sat idle for over a year.

MACHINERY

None.

ELECTRICAL

There was no effect on the fighting efficiency from electrical damage.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

This vessel is structurally of heavier construction than other ships exposed to the bomb. The damage that did occur was generally of a negligible nature and had contributing factors such as lack of maintenance, rust, or previous damage.

MACHINERY

The boilers of the NAGATO were more resistant to blast pressure than those of U.S. vessels at comparable distances from the explosion.

ELECTRICAL

As there was no significant electrical damage to the ship, no impressions or conclusions were formed by the observers.

V. Preliminary Recommendations.

HULL

Necessary superstructure should have faired lines, no recesses or pockets, and be constructed of 10 pound plate or heavier.

MACHINERY

It is recommended that the construction of boilers and uptakes of the NAGATO be studied with a view to considering the desirability of incorporating some of their features into the design of our vessels in order to make them more resistant to blast pressure.

ELECTRICAL

There are no recommendations by the inspecting group.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

HULL

There was no flooding and consequently no change in drafts as a result of the explosion.

(b) Structural Damage.

HULL

There is minor dishing of the weather deck between the bow and frame 60 with some slight buckling of joiner bulkheads below, particularly between frames 10 and 20. Minor cracks appeared in built up riveted frames in the same area. Between frames 60 and 72 the deck failed with a resulting dish about two feet in depth. The failure is manifested by parting of riveted seams, port and starboard, just aft of the uptake deckhouse. Beams and longitudinals below, with their supporting stanchions, failed completely. Slight dishing of the weather deck, with resultant damage to beams and longitudinals below, took place between frames 72-109 and 113-119. Severe dishing (12" - 18") occurred between frame 122 and stern and distorted structure below it. Damage to partition and other bulkheads between main and second decks was apparent in varying degrees between bulkhead 48 and stern. This was most pronounced between frames 60-72 and aft of 119. Closures, doors, and hatches were undamaged except in regions of boiler room uptakes, frames 60-72, and aft of 119. There was some very mild dishing of the shell, port and starboard, between frames 10 and 20, and, between frames 91 and 113, starboard.

Major superstructure damage appears on the starboard and after faces. Pole masts were bent in smooth curves in the direction of the port bow. Yardarms bowed forward. The joints showed no signs of failure. The tripod mast construction showed no failures in the legs or the deck connections. The loading on the foreleg, which foots on the first platform above bulkhead 43 caused local buckling in that bulkhead. Both the bulkhead plating and stiffeners in regions of the centerline were affected.

Struts between the pole mainmast and superstructure deck pulled the deck doubling plates out of the deck. Load on the after structure caused compression failure in centerline stanchions in the machinery spaces, i.e. after fireroom and engine room.

Both smoke pipes were laid over to port and forward until stopped by other structure. Light uptakes failed in the plating and at the joints.

The 1/4'' plating of the aluminum deckhouse on the after portion of the Navigation Bridge failed completely as did aluminum structural shapes. Aluminum rivets behaved poorly.

In general, plating less than 15# weight was unsatisfactory. Doors and hatches dished almost without exception, the hatches to the lesser degree. Deckhouse panels containing doors were more severely affected than solid panels.

MACHINERY

Both smokestacks were knocked over to port and severely crushed. Uptakes were distorted. Boiler casings were damaged structurally. Considerable damage was done to piping, and to the boat and airplane crane by deflection of supporting structures (bulkheads and decks).

ELECTRICAL

Structural damage involving electrical equipment occurred mainly in the following areas:

1. Second deck in quarters aft at frame 127.

2. Main deck forward in battery charging station, frame 48.

3. Main deck starboard center at frames 85 to 100.

4. Superstructure at base of both masts.

5. On main mast and foremast.

6. On forward superstructure and lookout stations.

7. After steering station.

8. All searchlight platforms.

(c) Other damage.

HULL

No comment.

MACHINERY

The casings of all boilers were badly blown out. Smoke indicators, air doors, air door operating gear and brickwork of boilers were moderately damaged. Both stacks were blown over. Uptakes were distorted at their upper ends. Suction flaps in forced draft blower intakes were bent. The after deck winch was thrown out of alignment and its electric controller crushed by deflection of the main deck. The boat and airplane crane was damaged structurally. There was considerable damage to piping (mostly to fire main risers near the main deck, and to small water piping on the second deck).

ELECTRICAL

No major damage to electrical equipment occurred during the test. No damage to electrical equipment occurred which would have prevented the ship from performing combat duty. Inoperable equipment is essentially as follows:

1. Circuits and equipment on masts and yard arms.

2. Searchlights, one-12", all 24", all 36".

3. A few ships service telephones on superstructure.

4. A few lights in superstructure.

5. A few ventilator sets in quarters aft.

6. After warping winch.

7. Emergency radio TBK transmitter, M.G. controller.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Radiant heat came from 165° relative and at an elevation of about 15° elevation. Paint was blistered and scorched on all exposed surfaces. Horizontal surfaces were not affected as much as vertical surfaces. Decks exposed to radiation were scorched as were all lines and cordage.

MACHINERY

There was no evidence of heat in machinery spaces. There was some scorched paint on the starboard sides of deck machinery.

ELECTRICAL

Cables on after side of main mast were scorched slightly by the radiant energy of the blast.

(b) Fires and Explosions.

HULL

There were no explosions.

A fairly large fire occurred when Army Quartermaster's gear, located on the main deck, between frames 112 and 128, was ignited by radiant heat. The vessel's teak deck was destroyed in way of the burned equipment, as were all life rafts that hung from turret 4 and those stowed on deck at about frame 125.

Burning particles from the fire started another on some fire hose, the burning of which destroyed adjacent wood decking and paint and started fire among lines in Boatswain's stores, A-102-1.

MACHINERY

There was no evidence of fires or explosions in machinery spaces or on exposed machinery.

ELECTRICAL

No electrical equipment was damaged by fires or explosions, except local lighting cables on second deck at frame 127 due to fire on main deck.

(c) Shock.

HULL

There was no evidence of shock damage.

MACHINERY

Some small piping (already badly corroded) broke apparently from shock. There was no other direct evidence of shock on machinery.

ELECTRICAL

No electrical effect was noted which could be attributed to shock.

A contact finger in the controller of the port deck winch broke.

(d) Pressure.

HULL

The pressure wave came from a bearing of about 170° relative. The pressure wave, which did extensive damage, exhibited a strong downward vertical component. This vertical pressure was evidenced by the deflection of the main deck aft and in the way of the well amidships.

The blast funneled through the fore and aft passageways in the after superstructure on both sides of the ship. The light bulkheads and doors in the passageways are distorted.

There are numerous cases of blast damage in areas sheltered from the direct blast and there are also evidences of funneling or focusing of the blast; as for instance, in the athwartship passageway, just aft of the wardroom.

It was noted that while the maindeck was badly dished, other horizontal surfaces stood up much better than vertical surfaces which were more nearly normal to the blast.

MACHINERY

Blast pressure caused damage to boilers and stacks, forced draft blower flaps, and caused structural damage affecting the crane, after warping winch, and piping.

ELECTRICAL

A positive pressure of extremely high value and a negative pressure were noted. No damage to electrical equipment occurred except as follows:

1. A light metal cable covering on after side of main mast carried away.

2. Vertical cable at frame 47 main deck was broken by door carrying away.

3. Some ventilating systems were made inoperable due to collapsing impeller housing.

4. The after warping winch was made inoperable by the collapsing of the main deck at fr ame 128.

5. Two batteries in battery lock were knocked out of battery rack and demolished due to bulkhead bending.

6. The Emergency Radio motor generator controller for the TBK transmitter was cracked and made inoperable by bending of bulkhead.

(e) Any Effects Apparently Peculiar to the Atom Bomb.

The intensity of heat and the high blast pressure at this range are peculiar to the Atom Bomb.

III. Effects of Damage.

(a) Effect on Propulsion and Ship Control.

HULL

No comment.

MACHINERY

All boilers were made inoperable, hence the ship was without steam power. It is estimated that approximately 96 hours would be required for temporary repairs by the ship's force to enable the ship to steam at very slow speed. Major repairs at a Naval Shipyard would be required before normal operation could be resumed. The forced draft blowers could not be operated until the bent flappers were straightened but this could be done by the ship's force within a few hours. The after warping winch would probably require a major

overhaul. Temporary repairs to permit operation of the crane could be made by the ship's force within two days. Damage to piping is only of local effect except that to the firemain riser at frame 128. This supplies water to the sprinkling system of the after 40 MM magazines, and water to this system was cut off by this damage.

Insofar as machinery is concerned, the effect of the test on ship control was to reduce available power to that furnished by the emergency diesel generators.

ELECTRICAL

Electrical damage had a negligible effect on propulsion and ship control.

(b) Effect on Gunnery and Fire control.

The forward 40MM ammunition hoist is inoperable electrically due to the vertical control cable breaking on main deck frame 47 when door collapsed.

(c) Effect on Watertight Integrity and stability.

HULL

Since there was no flooding and no appreciable displacement of heavy material, there was no effect on stability. All watertight boundaries and closures below the second deck remained intact, so that watertight integrity was not impaired below that level. Aft of amidships, above the second deck, watertight integrity was somewhat impaired by failure in the main deck and by the distortion of bulkheads and door frames.

MACHINERY

No comment.

ELECTRICAL

No comment.

(d) Effect on Personnel and Habitability.

HULL

The habitability of the ship was only slightly impaired as a result of the explosion. The loss of power would have reduced the services available in living spaces. Repairs in the galley would be necessary before meals could be prepared.

MACHINERY

It is believed that all personnel in the firerooms would have been casualties if boilers had been steaming at the time of the Test. It is not believed that any other personnel casualties would have occurred below decks. Habitability would have been greatly reduced by loss of steam power, and to some extent by damaged piping.

ELECTRICAL

No effect occurred other than the loss of a few ventilating units.

(e) Effect on Fighting Efficiency.

HULL

Failure of the polemasts, smoke pipes and certain fire control instrument foundations would have caused severe reduction in efficiency, through the effect on electronics, mobility and fire control. The longitudinal structural strength has been slightly impaired by the dishing of the main deck between frames 60 and 72, and 122 and stern; however, the stringer plates remained intact with very little distortion. The seaworthiness has been slightly impaired by the holding of the main deck between frames 60 and 72, and by the failure of weather doors and hatches topside.

MACHINERY

As the ship lost all steam power she was no longer an effective fighting unit.

ELECTRICAL

Electrical damage had only a slight effect on fighting efficiency.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

From the hull material standpoint, the ship could have been made sufficiently operable, by ship's force, to return to port for repair, but would not have been an effective fighting unit without shipyard repair.

MACHINERY

It is believed that on a modern cruiser, exposed as the PENSACOLA was, the damage to the boilers would not have been as heavy.

ELECTRICAL

The only electrical equipment damaged by the test was either in the direct path of the blast or in the way of structural failures which caused secondary damage.

Searchlights were the major item in the direct path. They were the cast aluminum design. It may be presumed that had they been of a later design, less damage would have occurred.

Cable and motor controllers suffered most damage due to structural failures. Suitable mounting arrangements such as now required by BuShips specification would have prevented most controller damage.

V. Preliminary Recommendations.

HULL

1. Light structures topside should be eliminated or built into the superstructure. These items include deck lockers, flag bags, light splinter shields, look-out tubs, etc.

2. The athwartship and fore-and-aft passageways should be closed in to prevent accumulation of blast pressure in restrictive locations. The superstructure should be joined wherever possible to avoid blast traps. Overhanding gun positions and platforms should be avoided for the same reason.

3. The design of cruiser stacks should be restudied. Possible developments are a squat conical stack which should be designed to survive high blast pressures and a two-strength stack of conventional dimensions consisting of a heavy lower section extending about six feet above the superstructure level and a very light upper section which is designed to survive only service conditions. In the second case, the blast pressure would be expected to carry the light upper stack over the side, permitting emergency steaming through the heavy stump.

4. Large areas of weather deck exposed to blast loadings (such as the well deck and after weather deck on PENSACOLA) might have a more uniform distribution of plating weights across the deck instead of concentrating the strength in the stringer. The design, location and number of supporting stanchions, bulkheads, etc., should be carefully analyzed to avoid discontinuities and concentrations and to limit deck deflection. Attention should be given to the design of stanchions supporting major structural members such as those in the engineering spares.

MACHINERY

1. Boilers, uptakes, and stacks should be made more resistant to blast pressure.

2. Deck machinery and piping should be supported in such a way that they are not likely to receive secondary damage from deflection of decks or bulkheads.

ELECTRICAL

Specific recommendations have been made under each item of "Detailed Description of Machinery Damage", where applicable.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The drafts of the ship are unchanged, i.e., 19' 6" forward, and 20' 6", aft. A pre-test list of 1/2 degree to port is also changed.

The flooding occurred in the inner bottom tank, C-909-F, apparently through an opened seam from the sea.

(b) Structural damage.

HULL

Light topside structure is damaged extensively. Both stacks are demolished. The principal structural damage is to the main deck. Maximum deflection of the deck is 16 3/4 inches at frame 66.

MACHINERY

Both stacks were completely severed at their bases. The forward one fell overboard, the after one fell over on the deck to starboard. There was some distortion of uptakes, especially above the main level. Casings were blown out on all boilers. A leg of the crane tripod mast was bent, probably by being struck by the after stack as it fell over. Deflection of bulkheads through which the crane control shaft passes caused it to bind. Several firemain risers and some small pipe lines were damaged by deflection of the supporting structures.

ELECTRICAL

Not observed.

(c) Operability.

HULL

The main drive and auxiliary machinery all appear to be in good condition. However, all boilersare damaged to varying degrees. None are in condition to light off. (Repairs requiring five days were necessary before boiler No. 6 could be lighted off).

Some electrical circuits above the main deck are grounded. Electrical equipment and circuits below the main deck are in good condition.

Ship control facilities are operable. The after main and AA directorscan be repaired within 24 hours, but the forward main and AA directors will require Navy Yard repairs.

Eight inch mounts 3 and 4 have no apparent damage. Mounts 1 and 2 are operable but in each, the left trunnion support is distorted and forced outward, causing misalignment of the bearing and excessive side thrust clearance. This may cause trouble under repeated firing of the guns.

Radio and radar antennae supports are extensively damaged. Enclosed electronic equipment has received minor or no damage.

MACHINERY

The casings of all boilers were blown out, the forward ones more than the after ones. Smoke indicators were damaged and moderate damage was done to the boiler brickwork. Both stacks were knocked off. Uptakes were distorted at their upper ends. Suction flappers of all forced draft blowers were bent. A large sheet aluminum dust pan under a ladder exposed to blast pressure fell on the aluminum vent cap of #3 main reduction gear, breaking the cap. A few minor leaks were started in #1 evaporating plant. The crane was damaged structurally. One motor whale boat was smashed and the engine fell out, damaging it. Several firemain risers and some small steam lines connected to radiators broke.

ELECTRICAL

Electrical damage affected ship control by the loss of engine order, steering, and shaft revolution telegraphs on the navigation bridge. Electrical power supply circuits to gunnery and fire control were not affected.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation came from an elevation of about 30 degrees and relative bearing of 230 degrees. Exposed paint has been charred. Manila and cotton lines are charred one thread deep.

MACHINERY

Except for blistered paint on the port side of exposed deck machinery, there was no evidence of heat on machinery or in machinery spaces.

ELECTRICAL

A wave of radiant heat struck the vessel from about 240 degrees relative bearing. The heat was of sufficient intensity to blister and char painted surfaces directly exposed, and to ignite fabric on the main deck aft.

(b) Fires and explosions.

HULL

Minor fires occurred in exposed cotton chaffing mats on the weather deck, aft and burned the wooden deck below. On the superstructure deck, aft, straw and wood shavings from a wrecked packing case burned. No explosion occurred.

MACHINERY

There was no evidence of fires or explosions.

ELECTRICAL

No electrical equipment was damaged by fires.

(c) Shock.

HULL

Shock damaged instruments and caused failure of instrument foundations in the superstructure.

MACHINERY

No damage was found that could be attributed to shock.

ELECTRICAL

Lack of general breakage withing the ship makes it doubtful if shock was present, although shattering of instrument glass on navigation bridge and spilling of mercury from both master gyros could have been caused by shock.

(d) Pressure.

HULL

Blast pressure is the major cause of damage to this ship. The principal damage is the severe deflection of the main deck between the forward and after deckhouses, and the buckling of the stanchions below. The pressure was downward and from the port quarter. Critical plating thickness seems to be about 10# plate.

MACHINERY

Blast pressure, and deflection of decks and bulkheads resulting from blast pressure, caused all damage to machinery. The blast apparently came from slightly forward of the port beam.

ELECTRICAL

A wave of pressure struck the vessel from about 240 degrees relative bearing. The pressure was sufficient to break the aluminum yokes on both 24" searchlights located above the signal bridge, and to break off both aluminum pelorus stands on the navigation bridge.

(e) Any effects apparently peculiar to the Atom Bomb.

HULL

An effect peculiar to the Atom Bomb is the radiant, directional heat.

MACHINERY

Blast pressure of this magnitude at the range of the SALT LAKE CITY from an explosion is believed to be peculiar to the Atom Bomb.

ELECTRICAL

The radiant heat is the only apparent effect peculiar to the Atomic Bomb.

III. Effects of damage.

(a) Effect on propulsion and ship control

HULL

The ship is immobilized by boiler damage.

Ship control is lost by disruption of electrical power and short circuited wiring in the superstructure.

MACHINERY

All boiler power was lost. It is estimated that 48 to 72 hours would be required for temporary repairs by the ship's

force to enable one boiler to be steamed at a low rate. No motive power would have been available until after extensive repairs to boilers, uptakes, and stacks.

The only effect on ship control insofar as machinery is concerned, would have been limitation of power. The diesel generators and emergency diesel steering equipment were not damaged and were fully operable after Test A.

ELECTRICAL

Ship propulsion was not affected. Ship control was affected by loss of engine order shaft revolution and steering telegraphs on the open navigation bridge.

(b) Effect on gunnery and fire control.

HULL

The use of AA and main battery directors is lost, some temporarily. The majority of optical equipment and all fire control antennae are disabled.

MACHINERY

No comment.

ELECTRICAL

There was no electrical damage.

(c) Effect on watertight integrity and stability.

HULL

The effect on watertight integrity and stability is negligible.

MACHINERY

No comment.

ELECTRICAL

Electrically there was no effect.

(d) Effect on personnel and habitability.

HULL

Casualties to men in exposed positions would probably have been high. Habitability, topside, would be curtailed by radioactivity. Fresh water would have to be supplied to the ship.

MACHINERY

It is estimated that there would have been a high percentage of casualties among fireroom personnel. It is not believed that any other casualties would have occurred among personnel below decks. Casualties among exposed personnel would have been high. Habitability would have been greatly impaired by loss of steam power.

ELECTRICAL

Electrical damage had no effect on personnel or habitability of the vessel.

(e) Total effect on fighting efficiency.

HULL

It is estimated that the fighting efficiency is reduced to negligible proportions. This is primarily due to loss of steam and damage to fire control equipment. This leaves only the turrets in operation by local control and power from emergency diesel generators.

MACHINERY

The effect on fighting efficiency from a machinery viewpoint was complete loss of steam power, the limitation of electric power to that furnished by the emergency diesel generators.

ELECTRICAL

The fighting efficiency of the vessel was only slightly impaired by electrical damage.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

If this ship had been engaged in combat at the time of damage, its condition would be serious due to the loss of power and damage to fire control equipment. From a structural standpoint however, damage is not serious. The effect on stability and watertight integrity is negligible. The effect on longitudinal strength is slight.

MACHINERY

Stacks in good condition would probably not have been knocked off but would undoubtedly have been severely damaged. The stacks of the SALT LAKE CITY were badly corroded before Test A.

ELECTRICAL

The vessel was subjected to sufficient damaging forces for the electrical equipment to be given a fair test of its ruggedness and suitability for use under such conditions. The only exception is the weakness of cast aluminum as a material for supporting columns.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

The overall loss in fighting efficiency which the ship has suffered could be materially decreased by changes in radar foundations and smokepipe design. Ten pound plate should be maintained as a minimum in exposed areas wherever possible. Overhangs should be avoided.

MACHINERY

Boilers, uptakes, and stacks should be made more resistant to blast pressure.

ELECTRICAL

It is recommended that cast aluminum be discontinued as a material for instrument cases and supporting columns.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural Damage.

HULL

The superstructure deck longitudinals, two meters to port and starboard of the ship's centerline, have compression strains between frames 141.6 and 147.3. Their connections to the face of turret number 2 have partially failed. The transverse beams in this area are also strained in way of the longitudinals and joiner bulkheads are buckled.

The aluminum sliding cover of the hangar is wrecked.

The foremast, a hollow wooden cylinder, is split from the point where it is keyed in the UP position to nearly the topmast point, a distance of approximately 40 feet. The mainmast tip, approximately 14 feet, is broken off and hanging nearby.

There is some minor damage to joiner bulkheads subjected to blast pressure.

MACHINERY

No comment.

ELECTRICAL

The failure of the roller top of the hangar deck damaged a few lighting fixtures below. A gyro-repeater was knocked from its

mounting due to the distortion of the shield on which it was mounted. Electrical equipment was otherwise unaffected by structural damage.

(c) Other damage.

HULL

No comment.

MACHINERY.

There was no damage to machinery of this vessel during Test A. All that was operable before the test was operable after the test.

ELECTRICAL

The damage to electrical equipment on this vessel consisted of the following.

1. Filaments of approximately 100 German lamps were broken.

2. A few lighting fixtures in the airplane hangar were demolished by the caving in of the roller top to the hangar.

3. The lens on the 60 inch searchlight was broken.

4. Two gyro-compass repeaters were knocked from their mountings but were still operable.

5. One battery powered telephone handset was smashed and the mounting cabinets for two telephones were distorted.

6. Two rudder angle indicators and three signal control boxes experienced failure of their rubber shock mountings.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Radiant flash heat came from about 340 degrees relative.

Lines and cordage are superficially scorched. Paint is scorched and blistered. Heat radiation effects are on vertical surfaces only with the exception of a scorching of the weather deck at frame 166.

MACHINERY

No evidence except for scorched and blistered paint on exposed side of machinery.

ELECTRICAL

The heat from the blast was directed from a direction of approximately 10 degrees on the port bow. It slightly scorched the paint on exposed electrical equipment but did no damage to the equipment.

(b) Fires and Explosions.

HULL

There was no fires or explosions.

MACHINERY

No comment.

ELECTRICAL

There were no fires or explosions.

(c) Shock.

HULL

There is no evidence of shock.

MACHINERY

No evidence.

ELECTRICAL

There was evidence that the vessel may have received shock since the filaments of approximately 100 german lamps, mostly in locations above the main deck, were broken. It is considered that the shock was not particularily severe since rough service lamps of U.S. manufacture located in similar locations were undamaged.

(d) Pressure.

HULL

The pressure wave approached the ship from about 340 degrees relative. Blast pressure has wrecked the sliding cover for the hangar, dished some li ght doors and sheet metal structures in exposed locations, and blown off or distorted 5 pound M.S. windshields on the bridge structure.

The critical plating weight appears to be about 7 1/2 pound M. S.

MACHINERY

No evidence.

ELECTRICAL

Air blast from the same general direction as the heat wave caused most of the damage to electrical equipment. This is indicated by the damage to the 60 inch searchlight and to the navigational and telephone equipment on the vessel. Although the lighting fixtures in the airplane hangar and the gyro-compass repeater on the 03 deck were damaged by hull distortion, the primary cause of this hull distortion was the air blast, the electrical damage being secondary in nature.

(e) Effects peculiar to the Atom Bomb.

HULL

The effects peculiar to the Atom Bomb are the presence of radioactivity, range of the radiant flash heat, and the range and duration of the air blast.

MACHINERY

None.

ELECTRICAL

There were no effects noted that are considered peculiar to the Atomic Bomb other than radioactivity and the intense radiant heat from the bomb explosions.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

A section of 14 x 12 inch cable conduit has been blown off the starboard side of the forward uptake at the second superstructure deck level.

MACHINERY

None.

ELECTRICAL

The effects on electrical equipment and ship control were very slight. Spares were available for the lamps that were broken The navigation instruments knocked from their mountings were still operable. The searchlight lens was the only item of electrical damage.

that could not have been repaired by the ship's force.

(b) Effect on gunnery and fire control.

HULL

The main battery director is damage and inoperable.

MACHINERY

No comment.

ELECTRICAL

Electrically, there was no effect on gunnery or fire control.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None.

(d) Effect on personnel and habitability.

HULL

There probably would have been some casualties among exposed personnel from heat and radioactivity, if the ship had been manned. The habitability of the ship is unimpaired.

MACHINERY

None below decks.

ELECTRICAL

Personnel might have suffered casualties due to the radiant heat and due to the air blast. These casualties would have been limited to those exposed directly to the blast. There might also have been personnel casualties as a result of radioactivity, however, the extent of such casualties is not known. The only effect on habitability would be radioactivity.

(e) Effect on fighting efficiency.

HULL

The failure of the masts has rendered certain electronic equipment inoperable by the destruction of their antennae. The fighting efficiency would also be impaired by the loss of the main battery director and by the injury of exposed personnel.

MACHINERY

None.

ELECTRICAL

Except for personnel casualties, it is considered that there would have been no effect, electrically, on the fighting effeciency of the vessel.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Structural damage is of a minor nature.

MACHINERY

The PRINZ EUGEN was outside the effective range of the explosion during Test A.

ELECTRICAL

Due to the distance of the vessel from the center of the blast the damage to electrical equipment was slight.

V. Preliminary Recommendations.

HULL

The effects of the test on this ship emphasize the necessity for restudy of the design of masts and of closures over large hatches.

MACHINERY

None.

ELECTRICAL

It is recommended that the use of resilient mounting of electrical equipment be carefully re-studied since such mountings are considered to be more susceptible than rigid mountings to failures due to air blast.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding; sources.

As soon as the radioactive water of the lagoon cleared sufficiently to permit a close approach to the SAKAWA, the time then being 1700 on "A" day, it was determined that her stern was open to the sea. As may be seen in photo page 30, she was down about two feet by the stern but was not settling appreciably. During the ensuing night the draft aft increased about 10 feet as shown in photo page 34. The vessel, which prior to the test had a starboard list of 1.5 degrees, was now listing to port. By 0930 on "A" plus one day the list had increased to 8 degrees, and by 1000 the main deck was awash amidships on her port side. At 1033 the SAKAWA rolled considerably to port and the stern commenced settling more rapidly. Photo page 36, shows the SAKAWA at 1034 on her port beam with about 400 feet of her side submerged. By 1035, see photo page 37, she was submerged up to her midships section. Her stern then appeared to rest on the lagoon bottom. After this time she settled more slowly until at 1043 her bow disappeared.

Flooding unquestionably started when the SAKAWA'S stern was ripped open to the sea by the air blast. Photos page 28, page 29 and page 30 show the large opening in the mangled stern. Poor watertight integrity, as proved by a pre-blast air test, permitted progressive flooding. After 24.5 hours of slow progressive flooding the main deck was awash. In the next hour rapid progressive flooding, probably due to poorly fitted and damaged hatches, vent trunks, and other fittings in the main deck, sent the SAKAWA to the bottom.

(b) Structural Damage.

Considerable structural damage on the SAKAWA was caused by the air burst. The stern was most badly damaged by the

blast. Its deck plating was crushed inward (See photo page 30) and shell plating about the counter was twisted and torn open in several places. Shell plating on the starboard side of the SAKAWA was badly wrinkled from approximately frame 145 aft as can be noted in photo page 28. This same picture shows a line of apparent shear between two plates of the sheer strake at frame 170. Photo page 35 is another view of the SAKAWA'S distorted stern. The wrinkles at frame 143, shown in photo page 31, apparently denote the forward limit of structural damage to the shell plating. The only reported structural damage forward on the SAKAWA was the wrinkling of the forecastle deck to a depth of about 18 inches at frame 35.

The superstructure aft of the bridge was smashed down and forward into a mass of twisted wreckage. The mainmast, as shown in photo page 31, was toppled forward and outward until its upper end overhung the port side by about one third its length. The aircraft crane was blown forward onto the main deck. In photos page 31 and page 32 , the stack can be seen smashed against the foremast tower which itself was badly distorted. The foremast was angled sharply forward from the tower onto the director house. The house, formerly situated on the main deck frames 95 to 105, was disintegrated. The bridge structure, though warped, is relatively intact. It is interesting to note that, forward of the main bridge structure, the top of the deckhouse between frames 75 and 80 was dished in about a foot. This can be seen in photo page 33 . Forward of this damage, a longitudinal bulkhead on the main deck buckled and also sheared vertically at frame 64, (See photo page 32).

The tops of the after mounts were crushed. The tops of the forward mounts were dished in a fore and aft V having a two foot maximum depression. The forward face of mount 1, also was dished somewhat.

Other miscellaneous damage is as follows:

(a) All life lines on the starboard side were laid flat.

(b) Many deck fittings such as bitts, chocks, deck winches, were dislodged.

(c) Access throughout ship was made hazardous and difficult by derangement of ladders, jammed doors, and fallen structure.

(d) Life boats and their stowages were wrecked; the davits aboard at time of test were blown overboard.

(e) Searchlight towers were destroyed. One tower is visible on photo page 32 between foremast and crumpled stack. Overhanging platforms forming part of superstructure and masts were demolished.

(c) Other Damage.

Machinery and electrical damage was unobserved.

II. Forc s Evidenced and Effects Noted.

(a) Heat.

None. However, frames numbers and name painted on stern (See photos page 30 and page 33 are clearly visible on port side of SAKAWA. This indicates that the blast came from the starboard side.

(b) Fires and Explosions.

A fire burned on the stern of the SAKAWA from shortly after burst until it was smothered by the ship's submergence. The fire was first identified in aerial motion pictures about 0.5 seconds after burst. This fire, pictured in photo page 25, raged for about two hours. It had died to a smolder (See photo page 34) when the SAKAWA went down.

(c) Shock.

Air blast as evidenced by direction of crumpling and falling of SAKAWA'S ravaged topside structure evidently struck from above and slightly to starboard of dead astern. A comparison of photos page 26 and page 27 show lateral displacement of SAKAWA by blast.

(d) Pressure.

Unknown.

III. Results of Test on Target.

(a) Effect on propulsion and ship control.

Not observed. It is probable that damage to the stern would have disrupted steering control.

(b) Effect on gunnery and fire control.

Not observed. The guns and torpedo tubes were removed before the test.

(c) Effect on watertight integrity and stability.

The watertight integrity of the SAKAWA was poor and apparently dependent solely upon an intact hull. The air blast which ruptured the hull destroyed the watertight integrity of the ship.

(d) Effect on personnel and habitability.

Unknown except for flooding effect.

(e) Total effect on fighting efficiency.

Complete destruction of fighting efficiency.

IV. General Summary of Observer's Impressions and Conclusions.

As it was possible to board and inspect the SAKAWA prior to her sinking, diving operations on this vessel were assigned low priority and eventually limited by a time factor to recovery of instruments. Hence no diver's report is available on this ship. Information garnered in this report was obtained from following sources.

(a) Photographs.

1. 16 and 35 MM motion pictures.

2. Aerial sequences of stills.

3. Tower sequences of stills.

(b) Gross Damage Report of Test A.

(c) Report of Technical Observer in PBM Charlie.

(d) Director of Ship Material and Other Initial Boarding Team Reports. Pre-test views of the SAKAWA, photos pages 12 thru 24 were inserted in the report for comparison with the other photographs.

Before accurate comparison is possible it must be noted that the airplane catapults, torpedo tubes, 6" guns and small gun mounts were removed from the ship prior to the test.

The explosion took place approximately 490 yards from and slightly to starboard of the SAKAWA'S stern. At the time of this burst the SAKAWA was headed approximately parallel with the PENSACOLA. When she became visible in aerial photographs, she appeared to be lying with her longitudinal axis about 30 degrees to the right of the axis of the PENSACOLA. The Technical Observer in PBM Charlie submitted the first verbal reports regarding the condition of the SAKAWA. At 1700 on "A" day the Director of Ship Material approached close enough to observe the SAKAWA'S damage from the RECLAIMER (ARS-42).

Observations were continued until darkness forced the withdrawal of the Initial Boarding Teams. The next morning when it was noticed that the freeboard aft was reduced from 12' 3" to less than a foot, an attempt was made, despite the fact that the ship was still radiologically dangerous, to tow her into shallow water. The ACHOMAWI went alongside at 0906 on "A" plus one day for this purpose. Before this could be accomplished, though the ACHOMAWI had the SAKAWA in tow and was pulling astern to get the ship clear of the array, the SAKAWA sank. When the ACHOMAWI cast loose the SAKAWA had been moved astern about 150 feet

V. Preliminary Recommendations.

None.

VI. Pre-test Statistics.

(a) Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel Oil	33%.
Diesel Oil	33%
Gasoline	None
Ammunition	None
Potable and Reserve Feed Water	95%
Salt Water Ballast	95%

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ship Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

The SAKAWA floated at an estimated draft of about 19 feet. No draft marks were fitted on the SAKAWA. Freeboard heights were measured forward at frame 10 and aft at frame 150 and found to be 23' 3" and 12' 3" respectively. A comparison of ship's plans and freeboard heights yielded the 19 foot figure. She had a list of about 1.5 degrees to starboard.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There is no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

This vessel has suffered minor structural damage to the elevator platform which was in the locked position at the flight deck level during test A. The pressure incident to the burst caused downward deflection of the platform with a resulting permanent set of 1 5/8 inches at the center. The deflection is accompanied by minor distortion of some of the structural members which support the platform. The damage is not of itself sufficient to interfere with normal operation. However, the deflection caused misalignment of the equalizing system which prevented operation of the elevator until ships force repairs requiring two hours were affected. Upon completion of these repairs the elevator was operable under manual, but not under automatic, control.

MACHINERY

The elevator platform was pushed downward by the blast pressure, damaging it structurally and damaging the equalizing and automatic control mechanisms underneath it.

ELECTRICAL

No comment.

(b) Fires.

HULL

The only fire aboard this ship started in Army Quartermaster equipment stowed on the flight deck, frames 105-113, port, for special test. The fire destroyed nearly all the test equipment and burned the flight deck underneath to about half depth.

The test equipment consisted of clothing, messing and outing gear, battle helmets, field stoves, etc. Much of this equipment had metal parts, having a large surface-mass ratio, which were insulated by packing from any ground connection. The theory that this fire may have resulted from heat induced in the insulated metallic objects is supported by the fact that exposed lines and halyards on or near the flight deck were not scorched.

MACHINERY

No evidence.

ELECTRICAL

The blast started a fire in Army quartermaster equipment on flight deck. No other fires and no explosions occurred. Reference 11, page 2.

(c) Shock.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

There was no evidence of shock found in any electrical equipment.

(c) Other damage.

HULL

Damage to the elevator equalizing system is discussed in section II - Machinery.

MACHINERY

The equalizing mechanism and automatic control mechanism were considerably deranged and damaged by deflection of the elevator platform. There was no other damage to machinery of this vessel during test A.

ELECTRICAL

There was no damage to electrical equipment.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

There is slight scorching of painted vertical surfaces normal to the burst. No scorching of the wood flight deck occurred.

MACHINERY

No evidence.

ELECTRICAL

Heat effects were not noted in detail, but blackening of paint work by radiant heat was observed. No electrical equipment was affected by heat.

(b) Fires.

HULL

The only fire aboard this ship started in Army Quartermaster equipment stowed on the flight deck, frames 105-113, port, for special test. The fire destroyed nearly all the test equipment and burned the flight deck underneath to about half depth.

The test equipment consisted of clothing, messing and outing gear, battle helmets, field stoves, etc. Much of this equipment had metal parts, having a large surface-mass ratio, which were insulated by packing from any ground connection. The theory that this fire may have resulted from heat induced in the insulated metallic objects is supported by the fact that exposed lines and halyards on or near the flight deck were not scorched.

MACHINERY

No evidence.

ELECTRICAL

The blast started a fire in Army quartermaster equipment on flight deck. No other fires and no explosions occurred. Reference 11, page 2.

(c) Shock.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

There was no evidence of shock found in any electrical equipment.

(d) Pressure.

HULL

The pressure wave was from a relative bearing of about 180 degrees. It caused distortion of light metal bulkheads aft under the flight deck and deflection of the elevator platform.

MACHINERY

Blast pressure pushed in the elevator platform near its center. The blast pressure appears to have come from near the starboard beam.

ELECTRICAL

No pressure effects in any electrical equipment occurred.

(e) Any effects apparently peculiar to the atom bomb.

HULL

None.

MACHINERY

A blast pressure sufficiently high to cause damage at the range of the SARATOGA from the explosion is apparently peculiar to the atom bomb.

ELECTRICAL

No effects peculiar to the atom bomb were found in any electrical equipment.

II. Effects of Damage.

(a) Effects on machinery, electrical and ship control.

HULL

Not observed.

MACHINERY

The airplane elevator was made inoperable by damage to the equalizing and automatic control mechanism. Very limited operation could be restored by the ship's force in about 2 hours. The elevator would be of little or no value for handling airplanes until after complete repairs. It is estimated that these would require approximately 6 days work by a tender. There was no other damage affecting machinery.

ELECTRICAL

None due to damaged electrical equipment.

(b) Effect on gunnery and fire control.

HULL

Not observed.

MACHINERY

No comment.

ELECTRICAL

None due to damaged electrical equipment.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None due to damaged electrical equipment.

(d) Effect on personnel and habitability.

HULL

None.

MACHINERY

No casualties would have occurred among personnel below decks. Habitability was not affected.

ELECTRICAL

None due to damaged electrical equipment.

(e) Total effect on fighting efficiency.

HULL

This vessel has one elevator which was made completely inoperable until the cause of the failure was determined and corrected. It was then operable only under manual control. This would have seriously reduced the military effectiveness of the ship under conditions which require maximum use of plane servicing facilities and rapid movement of planes between the flight and hangar decks.

MACHINERY

The fighting efficiency of the SARATOGA as an aircraft carrier was reduced out of proportion to the total damage by inoperability of the airplane elevator. As far as machinery is concerned, the test had no other effect on fighting efficiency.

ELECTRICAL

None due to damaged electrical equipment.

IV. General Summary of Observers Impressions and Conclusions.

HULL

Structural damage to this ship was minor.

MACHINERY

The arrangement of the equalizing and automatic control mechanisms of the airplane elevator on this vessel is an obvious point of weakness with regard to an attack of this nature.

ELECTRICAL

Blistering due to radiant heat, a fire caused by the heat and minor blast pressure damage were the only effects of the atomic bomb.

V. Preliminary Recommendations.

HULL

Study should be given to the design of elevators which will remain operable when moderately distorted.

MACHINERY

The design of elevators of carriers now in service and in reserve should be studied to determine whether they would be made inoperable by moderate deflection of the platform. If so, this condition should be rectified.

ELECTRICAL

No recommendations are warranted by the conditions observed on this ship.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test:

(a) Drafts after test; list; general areas of flooding, sources.

The drafts of 23 feet zero inches forward, and 23 feet six inches aft are unchanged as a result of the test. There was no list before the test and it is now about 5 degrees to starboard. There are several reasons for the list, (1) removal of planes, test gear, and structure from the port side by the blast; (2) shifting of port side weights to starboard, such as catapult machinery, furniture, planes in hangar, hangar side plating, etc.; (3) flooding of starboard shaft alley; (4) movement of hangar bents and flight deck and stern structure about 1 foot toward the starboard side. The after diesel generator compartment was flooded to a height of 6 inches above the bottom of the emergency distribution switchboard. The source of flooding was due to a slow progressive leak from starboard shaft alley.

(b) Structural damage.

HULL

Superstructure: The superstructure on this ship is here considered to be the island structure, the stacks and the radio masts. All pipe frame structure and the platforms supported thereby have been blown down and off the ship by the pressure wave. The stacks have been collapsed and twisted but have remained generally in place. Radio masts have universally been twisted, bent or ripped from their locations. The island structure itself shows some minor dishing of the exposed bulkheads but is intact and usable. Doors on exposed bulkheads are severely dished and are inoperable, and the door at the hangar deck level has been torn from its hinges.

Hull Flight Deck: Between the forward edge of the flight deck and bulkhead 45, the damage to the deck is insignificant except for the depressing of the forward edge of the elevator opening. The deck is undistorted and entirely usable. Along the port and starboard sides of the elevator opening there is no perceptible damage. Aft of the forward elevator opening the deck shows the first sign of injury, which manifests itself by a slight warping toward the port side. The starboard side remains very nearly in original alignment while the port deck edge rises rapidly, until at the expansion joint at frame 63 1/2 it is several feet above its normal position. The expansion joint has not opened perceptibly from its position before the test. The surface of the deck is in good condition materially except for two small burned areas at about frame 59 where a test airplane was located.

Beginning at the expansion joint, frame 63 1/2, the flight deck is very sharply hipped along the centerline with the wood decking broken, and several feet of the thin steel deck plating below is split. Between the expansion joints at frames 63 1/2 and 84 1/2 the deck, on the starboard side, begins to rise at the deck edge and progresses in a straight line to the hip at the centerline. On the port side between these frames there is little change from the normal position of the deck between the edge and approximately eleven feet inboard of it. From here the deck peaks sharply in a straight line to the hip at the center. In addition to the transverse deformation, the longitudinal run of the deck rises from 63 1/2 in a fair curve to about 7 feet above normal at frame 84 1/2. The sharp peaking disappears at about frame 80 where it fades into a smooth arch which continues past the expansion joint at frame 84 1/2. Except for the splintering of the wood at breaks along the centerline the surface of the deck is in materially good condition.

Between the expansion joints at frames 84 1/2 and 111 1/2, the flight deck drops in a relatively smooth curve from about 7 feet above normal to a generally normal position at 111 1/2. The ridge in this area is more pronounced because the deck maintains its normal position for about nine feet inboard of the deck edge both port and starboard, thus making a much sharper angle of rise. The wood decking here is also splintered and broken and the thin steel plating

underneath split over a considerable portion of its length. At approximately frame 95 there is a tear in the steel plate extending across most of the deck.

The after most section of the flight deck; frame 111 1/2 to the stern, is badly damaged. Between 111 1/2 and the forward edge of the after elevator opening the deck is about normal. There is a slight depressing of the deck all around the opening, and the starboard side of the deck is in fair material condition except for a slight rise towards the stern. Aft of the elevator opening and to port of the starboard side of the opening, the deck is not only not usable but is also relatively dangerous for walking. The area is badly burned and heavily distorted to port of the centerline aft of frame 132. The after edge of the deck rises at an angle of approximately 45 degrees on the port side to a point about 20 feet outboard of the centerline. At this point there is a void in the deck, which extends forward to about frame 136. This corner of the deck which has been blown away by the blast, overhund the boundaries of the ship.

The deck is not usable as a carrier deck, and aft of frame 63 1/2 is not usable for any purposes.

Gallery Level Walkways: On the starboard side there is little discernible damage, but on the port side the walkways and overhanging tub tubs are either missing or so sharply forced upwards that the positions are useless.

Gallery and Forecastle Decks Forward of Bulkhead 45: Structural damage on these decks is limited to minor distortion of joiner bulkheads and relatively few cases of foundation displacements.

Main Deck: There is little damage to the main deck forward of bulkhead 45. From this bulkhead aft, the deck has been forced down in way of both elevators by the pressure wave which entered the hangar space, and in way of the hangar deck by the load transmitted through the transverse the longitudinal floors between the hangar and main decks. The area affected extends aft to bulkhead 126 and about 20 feet each side of the centerline. A maximum depression of 14" in the forward elevator well occurs at

frame 53 on the centerline; in the after well the maximum is 15'' at frame 122 and approximately nine feet to port. The maximum depression in way of the hangar deck is about fifteen inches, and the average depression throughout this area is about 5''. Aft of bulkhead 126 the main deck is badly damaged, especially on the port side. Areas exist wherein the depression of this deck is as much as two feet, and aft of 136, port side, the deck is ripped along the shell and has been folded under itself. On the starboard side of this deck, between frames 126 and 132, fire and low order explosions torpedo air flasks occurred, which caused general havoc throughout the stern of the ship aft of bulkhead 144. This internal source of damage coupled with the direct effect of the atomic bomb burst have made the bulkheads, decks, doors, equipment, furniture, ventilation, and electrical facilities useless.

Second Deck: There is practically no damage to the second deck area from the stem to bulkhead 49. Aft of bulkhead 49 the second deck bulkheads generally buckled from the loading exerted by the main deck, but there is no discernible buckling of bulkheads below the second deck or depression of the second deck forward of bulkhead 101. The deck is depressed slightly between frames 101 and 119 aft of which very severe dishing and distortion of the deck begins, for the most part of the port side where the extreme damage to the port shell has caused long accordian pleats in the deck. Water-tightness throughout this deck aft of bulkhead 49 has been destroyed due to damage to door frames, doors, vent ducts, and cable runs.

Third Deck: There is no damage forward of bulkhead 57 which shows slight buckling. Between 57 and 91, the bulkheads show signs of elastic deflection of the second deck but have retained their tightness. The deck has not been depressed. There is some slight tripping of the port shell frames between frames 91 and 101. Aft of frame 101 the tripping and buckling of the frames becomes very pronounced. Aft of 113 the buckling is very severe and is accompanied by a definite displacement of all port side structure to starboard.

Below Third Deck: There is some slight damage to joiner bulkheads and some loss of water-tightness.

Shell - Starboard Side: The sheer strake, frames 12 to 15, shows local damage caused by the service ships when along side the INDEPENDENCE in the target area. The sheer strake and the strake next below, show a slight herringbone stress pattern at

frame 20. The side panelling just above the main deck, frame 30-36, is dented and dished from contact with service ships - also in the target area. No other evidence of damage from the test exists between frame 36 and 120 where a deep, wide wrinkle becomes apparent at the main deck and travels diagonally aft to frame 125 at the waterline where it merges with a series of short diagonal panel depressions, running in the same direction, which continue to the stern. The side panelling aft of bulkhead 126 and above the main deck is blown out as a result of damage in the torpedo workshop.

Shell - Port Side: There is only the faintest suggestion of panel dishing between the stem and frame 40. In the neighborhood of frame 40 there is some scorching of paint and the beginnings of discernible panel dishing which increases in severity to frame 50, where individual panel failures become apparent. At frame 70, traces of the blister longitudinals appear and continue to frame 106 with the depressions between them reaching maximums of about 18 inches at approximately frame 95. Longitudinal dishing of the blister plating is evident to frame 112. Between frames 112 and 126 the disformation of the shell is severe but varied. Aft of bulkhead 126 the wilted appearance of the port side, both above and below the main deck, bears striking witness to the tremendous force of the attacking instrument. The original character of the side plating and companion structure can be determined between frames 126 and 134 above the main deck although it is badly mauled. Between the main and third decks the shell is relatively smooth from frame 126 to 134 but shell plating and framing have been forced to starboard slightly leaving the third deck clearly defined. Below the third deck from 126 to 134 there is a deep depression giving the appearance of collision damage which is, however, due to lack of adequate framing in this area. Aft of frame 134, above the main deck, the side plating and structure is generally collapsed to frame 144. Below the main deck the sheer strake is torn as is the connection between the main deck and the sheer strake. The shell plating has been pushed to starboard and down, almost to the third deck, with deep valleys existing between the framing. The transom between the port side and centerline has collapsed and the main deck droops over the wreckage aft of 134.

Hangar Space: All but three of the light cover plates between the heavy port side columns which support the flight deck, have been blown out; some across to the starboard side of the hangar

and some overboard. The columns, with the exception of these just forward and just aft of the expansion joints, have been generally inclined slightly to starboard at the top, bent slightly forward and twisted in a counter-clockwise direction. The "wobble bent" columns, those just forward and aft of the expansion joints, have been ripped from the deck at their riveted connections to the hangar deck and definitely deformed. The light cover plates on the starboard sides are less affected by the blast, about half remaining in place. The main columns on the starboard side with one or two exceptions, show no effect of the blast. Most of the "wobble bent" columns offer only a little evidence of the tendency to lift which characterized the action of those on the port side. Both elevators have been carried over the side, bulkhead 45 is deeply dished in horizontal valleys between the forward decks, bulkhead 126 is bulged into the hangar space, and the hangar deck is deeply dished, between the longitudinal floors from frame 56 to 115. The maximum depth of this dishing occurs along the centerline at frame 89 and amounts to 15".

MACHINERY

The stacks were badly crushed and distorted at their bases and lower parts where they extend beyond the side of the ship at the hangar deck level. The upper portion of stacks #1, 3, and 4 carried away. Severe distortion of the hull near the stern is believed to have caused misalignment of the main shafting. Both airplane elevator platforms were blown overboard, pulling apart the wire rope cables. The guide rails on the port side of the after elevator were bent. The airplane crane was badly damaged structurally and is leaning outboard at an angle of about 15°. A great deal of damage was done to piping, especially in the hangar and on the flight deck, by failure or deflection of supporting structures. The port boat winch was blown overboard.

ELECTRICAL

Extensive damage to electrical equipment and wiring was a result of the damage to the superstructure and after portion of the hull by the air blast from the bomb. Deformation of bulkheads, panels, decks, and flight deck supports caused rupture of electrical boxes, panels, and appliance frames. Missiles, produced

when ship's structure was torn loose from the port side and blown over to the starboard side, or overboard, caused damage to all electrical equipment in their paths.

(c) Other damage.

HULL

All steam machinery below the third deck is operable if steam can be supplied. All uptakes are collapsed above the hangar deck and temporary uptakes and temporary exhaust ducts must be provided before the boilers can be lighted off. The diesel plant, consisting of two 150 KW generators, is operable. The ship control station on the bridge is operable, as in the ship control station at the forward end of the port gallery walkway. Electric lighting circuits below the main deck aft of bulkhead 45, and all circuits forward of bulkhead 45 will require only minor repairs - a few hours work by ship's force - before operation is possible. Telephones and loudspeakers are in approximately the same condition although there are some scattered phones in heavily damaged areas, which are not operable. The steering gear is operable and can be controlled from both main and secondary stations. Gyros and repeaters, in general are operable. The anchor windlass is operable. Fire control equipment is generally not operable. Below decks electronic equipment is practically all operable, while radar and other topside electronic equipment is disabled. Not all guns normally aboard the ship were in place for the test. The remaining guns on the port side are not operable; but, those on the starboard side, except the one furthest aft, and those in the forecastle are operable. Arresting gear sheaves and barrier stanchions on the flight deck appear to be intact and are generally operable, but the hydraulic gear, which is supported on the underside of the flight deck between elevators, dropped to the hangar deck because of failure of the supporting bolts when the flight deck buckled. Such hydraulic gear located aft of bulkhead 126 remained in place, but was seriously damaged from fire and distortion of the supporting structure. The elevators were blown off the ship but the elevator machinery appears to be intact except for entangled wire and a few dislocated sheaves. Upper sheaves around the elevator openings in the flight deck are warped and out of alignment. The airplane crane is not operable, being off its roller path and is cocked to starboard about 15 degrees and 10 degrees forward. The bushings, bearings, and holding down clips are marred, gouged, and somewhat mangled,

but the ship's force should be able, with a few days work, to repair and reseat the crane for use. Except for electrical connections the hoisting machinery is intact and usable. The training "A" end is intact but the "B" is shifted slightly, and is inoperable. The starboard catapult accumulator bottle has shifted about 1" to starboard and opened some of the oil line flanges. This catapult can be returned to service very quickly. The port catapult electric motor and pump have been displaced about 6" to port, oil lines are broken and gauge and control panels displaced to starboard. The catapult is inoperable and is not susceptible to quick repair. All four radio masts were in the up position for this test and were blown to starboard, generally folding over the flight deck edge. Their operating machinery, was deranged due to general buckling of all structure along the gallery walkway.

MACHINERY

No damage to the main propulsion plant or its auxiliaries was found by visual inspections and operational tests, the main engines being turned at propeller speeds of 20 RPM. However, this is not a conclusive test of the main shafting, which is believed to be out of alignment. All boilers were made inoperable by damage to stacks and uptakes, which completely sealed the gas passages. There was severe damage to piping in the hangar and on the flight deck aft of frame 50, and slight damage to piping (especially refrigeration piping) elsewhere. Wire rope cable, which broke when the elevator platforms carried away, is badly entangled in the elevator machinery. The airplane crane, in addition to being damaged structurally, sustained damage to the machinery. The rotating machinery of the crane is probably beyond repair. Ventilating fans in the hangar were demolished. The starboard boat winch, after casualty power generator diesel engine, and equipment in the carpenters', shipfitters', and torpedo workshops were burned out by the fires and explosions in the after areas of the ship and are beyond repair.

ELECTRICAL

The main electric plant, distribution switchboards and main engine and boiler auxiliaries were undamaged and operable, but due to structural damage to stacks, the boilers could not be steamed until temporary repairs were accomplished. The forward and after emergency diesel generators and associated distribution switchboards were undamaged. The after unit was not operable before the test.

The forward unit could be used to supply necessary power for lighting and operating electrical auxiliaries until the main plant could be put into service.

Vital ship control telephone communications remained intact and operable. All navigation lights were completely destroyed. It would have been necessary to shift steering control to central station until emergency repairs could be completed on the bridge steering selsyn control cable.

The fire control signalling and communication systems were inoperable due to damaged wiring equipment at operating stations resulting from structural failures.

Three of the four heavy machinery guns were inoperable electrically due to rupture of power supply cables when mount foundations were deflected upward by bomb blast pressure.

II. Forces Evidenced and Effects Noted:

(a) Heat

HULL

The entire flight deck is very noticeable darkened, apparently from the heat of the blast; curved surfaces indicate a source approximately broad on the port beam and shadows support the conclusion that the relative bearing of the burst was about 225 degrees. All surfaces facing the burst are darkened and there is some scorching of paint on the inboard (port) side of the island structure. Some piping in this area shows slight blistering. There is no damage to interior paints. Paint on planes in the hangar show but slight scorching and in many cases none at all. Some manila line was scorched to approximately 1/32" depth. Cloth seam tape and the olive drap paint on an army portable radar unit are completely gone on the side exposed to the blast.

MACHINERY

Screwed union joints at gage line valves of gasoline filling stations #1, 3, and 6 pulled apart. Apparently the nuts

were expanded by heat of the secondary fire that raged in this area. These stations are at the outer edge of the flight deck. Other evidences of extreme heat topside are blistered paint and charred wood, canvas, leather, etc.

ELECTRICAL

Radiant heat had no appreciable effect except the blistering of exposed paint and destruction of plastic lens on indicating instruments.

(b) Fires and explosions.

HULL

There were severe fires and low order detonations but no violent explosions.

The port side aft was blown inward by the A-bomb burst, exposing about six compartments containing some bedding, and a small amount of lumber in the shipfitter and aviation metalsmith's workshops. There was, undoubtedly, some acid and paint in these shops, in the battery repair shop and in the torpedo workshop. Some of the materials in the shops, which were open to each other and to the weather - from the effect of the blast - caught fire, either from the heat of the burst or from a source which may never be determined. This fire spread through practically all compartments aft of bulkhead 126 and above the main deck, and into compartment C-204-L on the 2nd deck between bulkheads 126 and 132. About 1436 on "A" day, the fire reached the twelve torpedo warheads in compartment C-101-E on the starboard side of the main deck between frames 126 and 132. There were air flasks in the compartment and at least one Mk 24 mine. It is, of course, impossible to establish an exact order of events within the compartment, but it seems probable that the heat of the fire approaching the compartment raised the temperature sufficiently to cause exudation of the warhead filler. This filler would burn fiercely thus causing a further increase in temperature within the compartment which probably caused the torpedo air flasks to explode. Torpedo airflasks were ruptured and the propellers and tail pieces of the Mk 24 mine was found as a fragment in the compartment. The smoke and flash patterns on "A" day showed a series of bursts and flashes compatible with repetitive burning of exudate and failure of airflasks.

All the material in the compartment appeared to be burning about 1400 as the smoke was most intense and voluminous. This fire was extinguished on the morning of "A" plus 1 day. This flurry blew out part of bulkhead 126, ripped the starboard shell practically the full length of the compartment, blew up the overhead and ripped the main deck - thus, spreading the fire into compartment C-204-L where bedding and shoring timbers burned. The heat from this general conflagration aft of bulkhead 126 caused the smoldering and then burning of the wood covering of the flight deck. The heat was sufficiently intense to cause the waterproofing compound used with the wood decking to become generally tacky and in some spots became fine ash. Acetylene and oxygen bottles in the shipfitters shop were displaced but intact.

A fire, probably of secondary origin, occurred in the diving gear locker on the starboard side of the main deck between frames 141-144. The gasoline engine drive for the air compressor located in the compartment has been blown from its foundation and is on the deck. The fuel tanks are burst open. A possible source of this fire, which gutted this compartment and the washroom to starboard, could be the gasoline spread when the fuel lines to the tanks were ruptured. Heat from the fire aft by bulkhead 126, may have ignited this gasoline.

Burned and charred areas at approximately frame 58, port side of the flight deck were caused by the burning of an airplane stowed here. The pontoons of the plane were torn from the plane causing the second burned areas.

An army F-1 trailer has been displaced, from its position on the flight deck near the after elevator, into the elevator well, and is badly charred. The movement is probably the result of the deep starboard roll. The tires are destroyed except for a few charred fibres. Hose, lying near has burned to the canvas casing, and wooden strips are heavily charred. These strips were part of the securing equipment. The source for this fire could have been the fire in the torpedo stowage space.

Although some warheads would be in compartment C-101-E under operating conditions, the normal stowage is the magazines. Warhead and torpedoes in the maga-

zines were not damaged nor were those on planes. Ammunition in ready lockers has not beem harmed. nor has the gasoline in the regular stowage tanks.

MACHINERY

Fires and secondary explosions occurred in the hangar, on the flight deck aft of frame 50, and in the upper decks near the stern. These burned out the diesel engine of the after casualty power generator, the starboard boat winch, and equipment in the carpenters', shipfitters', and torpedo workshops.

ELECTRICAL

A fire was started in after port quarter from an undetermined cause. All electrical equipment in the burned out areas was completely destroyed by the fire and explosions.

(c) Shock

HULL

There are many conditions of fittings and equipment on this ship which are somewhat characteristic of shock. There are some, although very few electric light bulbs broken. Machinery, such as both catapult elements and the airplane crane, has been shifted from the assigned location. A drinking fountain at frame 27 near the centerline is shifted several inches to port but no connections except the drain are broken. The relatively heavy hot water heater, located in the officers washroom, gallery level, frame 27, has also shifted several inches to port and several of the connections are broken. A large part of the furniture in the gallery and forecastle levels has broken from the footing and shifted generally, but not in all cases, to starboard. Heavier items have broken loose, while lighter units show strain and/are partial failure of securing clips. In the middle portion of the ship, crew's bunks, furniture and galley equipment has shifted to starboard or jumped out of the footings. Some of the above is very likely due to the deep starboard roll of the ship, and some to vibration or whipping but it is not very probable that shock, in the sense implied by impact, played a very distinctive part in the injury to this ship.

MACHINERY

There was no damage to machinery that could be specifically attributed to shock.

ELECTRICAL

Some indication of shock on electrical equipment mounted on bulkheads was apparent although not enough equipment was damaged in this manner to substantiate any definite conclusions.

(d) Pressure

HULL

The great bulk of the structural and attendant incidental damage was caused by the pressure wave. The pressure front struck almost normal to the port shell from a source about 225 degrees relative bearing. There are five principal areas of damage:

1. Port side aft of bulkhead 126 above the waterline.

2. The hangar area, including that deck and the flight deck.

3. The port shell forward of bulkhead 126.

4. The port and starboard walkways and island structure including the stacks and uptakes.

5. Interior spaces.

The damage aft of bulkhead 126 and above the waterline was so universal that no critical scantlings could be determined, and it is believed not to be feasible to provide against such damage at the range involved because a ship of this size would not be able to handle the required plating or framing weights.

In the hangar space also, there was no structure which satisfactorily withstood the blast pressures sufficiently well to

establish a critical set of scantlings. It is true that the starboard side is usable; but the port side, which took the direct blast and has similar scantlings, is not. There it is a matter of orientation with respect to the blast. The comment that adequate plate and framing weights would probably be too heavy for the ship applies here also.

On the port shell and blister plating, between frames 126 and 50, the plating, which varied from approximately 30# to 15#, was sufficient to keep the structure tight but did not prevent dishing, in most cases, very severe dishing. There was some minor damage to the 12# to 20# plating of the shell forward of frame 50. Although the ship probably could get back to a repair base without trouble from the plating, between frames 50 and 126, there is a definite loss in strength - for which reason the critical scantlings would be somewhat over these provided. The scantlings forward of frame 50 are satisfactory and probably critical for that particular distance and orientation from the burst.

The scantlings of the walkways and island structure may be considered critical in spite of the failures in the port walkway, since the detailed structure of the walkways and gun stations generally is in usable condition. The cause of failures insufficient connection between the walkway and shell of the ship.

Scantlings of interior spaces were satisfactory for the purpose but could not be lightened.

Broadly, the failure was collapse or incipient collapse under the influence of pressures far in excess of those for which the structure was designed. Aft of bulkhead 126 the structure, acting as a series of panels was moved bodily from its assigned location and so badly damaged that collapse was accompanied by boundary failure and tears with the panels. The condition of this area was worsened by fire and low order explosions to the extent that definition of particular types of failure was lost. Forward of 126, panel failures of various degrees are clearly indicated. Columns and other structure within this general region failed, largely in connections as a result of various panel failures. Forward of bulkhead 45 panels indicated incipient failure by light dishing or slight crumpling of the bottoms of stiffeners.

There was a minor amount of displacement of equipment and machinery.

MACHINERY

The blast pressure of the explosion caused the major damage to the stacks, airplane elevators, crane, and some of the damage to piping. This pressure caused failures and deflection of decks and bulkheads which in turn, caused most of the damage to piping. The pressure wave appeared to have come from the port quarter.

ELECTRICAL

Air blast pressure from about 240 degrees relative was indicated throughout the major damaged areas due to the manner in which the structural members on which electrical equipment was supported were ruptured and blown over the side.

(e) Effects apparently peculiar to the atom bomb.

HULL

Other than the radiant heat there were no effects noticed which are peculiar to the atom bomb.

MACHINERY

The very high magnitude of blast pressure is apparently peculiar to the atom bomb.

ELECTRICAL

The blistering of paint by radiant heat and the presence of radioactive material on exposed surfaces were the effects noted peculiar to the atom bomb.

III. Effect of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

None, except for crushing of boiler uptakes.

MACHINERY

The ship was left without steam power and hence was immobilized. Temporary repairs to enable the ship to steam at slow speed would require at least 4 days. Damage to gasoline piping would have greatly accentuated the effect of fires and explosions if the ship had been operating under war conditions. Damage to gasoline, firemain, and water curtain piping would have handicapped efforts to fight the fires. The firemain in the hangar and on and above the flight deck level aft of frame 50 was inoperable except for a few connections on the port side. The airplane elevators were left useless as their platforms were blown overboard. The crane is inoperable. The hoisting gear of the crane could have been made operable for emergency use by a tender within about 24 hours, but the rotating gear is probably beyond repair. The port boat winch is missing. The starboard boat winch, the diesel engine of the after casualty power generator, and the carpenters', shipfitters', and torpedo workshops are beyond repair. The refrigerating plant is inoperable but could be made operable by the ship's force within 2 days. The main shafts were believed to be out of alignment making high speed impossible even if boiler power for same were available.

The test had little effect on ship control from a machinery point of view, except to limit power available to that furnished by the two emergency diesel generators and the forward casualty power generator.

ELECTRICAL

No effect on electrical equipment associated with propulsion. Damage to bridge steering selsyn control cable, the loss of approximately three pounds of mercury from each of the master gyro-compasses and complete destruction of navigation lights were the most vital casualties to ship control.

(b) Effect on gunnery and fire control.

HULL

Assuming that guns were mounted in all the locations provided, approximately 75% would be inoperable; 50% of the 40MM and all centralized fire control would be lost. Ammunition supply is intact.

MACHINERY

No comment.

ELECTRICAL

Fire control systems and communications were badly damaged and in most cases inoperable due to structural failures rupturing wiring and wiring equipment. The power and control cables to three of the four (4) heavy machine guns were severed under gun mounts when foundations were deflected.

(c) Effects on watertight integrity and stability.

HULL

The hull is non-tight on the second deck aft of bulkhead 57, on the third deck aft of bulkhead 91, and on the first platform aft of bulkhead 113. This lack of watertight integrity is the result of buckling of the bulkheads under the main and second decks. The bulkheads generally buckled first through access door openings, thus leaving the closure warped and incapable of being made tight. Openings in bulkheads for large vent ducts were easily vulnerable because the vent ducts, being weaker than surrounding structure, tended to fail early and have left the bulkhead non-tight. In several instances bulkheads have been torn at hard spots formed by the intersection of structure members. The main deck has a small tear at frame 113 near the centerline, a larger one near the centerline at about frame 122 and one approximately 12 feet long on the port side just aft of frame 132. These are all transverse tears. There is a large fore and aft tear in the main deck, frames 128 to 131. In accordance with present naval practice the bulkheads throughout the mid-length of the ship are tight only to within about 15 inches of the main deck. Below the first platform the ship is tight except for an occasional compartment aft of bulkhead 126. The port shell

is generally open aft of bulkhead 132 above the third deck. The fragment hole at frame 68 has opened one of the blister compartments, B-304-V. At the hangar deck level all ventilation intakes and uptakes have been either blown away or completely ruptured and many of the closure fittings of these systems on the main deck level are distorted. Due to the list, several of the tears in the port shell are lifted out of reach by the swell in the lagoon and the ship is not taking water. At sea, however, she would be subject to progressive flooding within the limits noted which could be dangerous if the damage control crew could not keep the flooding down. Stability has changed very little.

MACHINERY

No comment.

ELECTRICAL

Electrical damage had no effect on watertight integrity.

(d) Effect on personnel and habitability.

HULL

Assuming that the ship was operating as an aircraft carrier with the crew at battle stations, it is probable that fully half her crew would be immediate casualties from the effects of heat, pressure, and radioactivity. Probably a large proportion of the remainder would be subject radiation sickness after several hours or days. Although there is considerable loss in habitability due to reduced ventilation and lighting, and the shifting of galley equipment and furniture, the ship is generally habitable forward of bulkhead 126. Some compartments aft of that bulkhead can be used after considerable cleaning up.

MACHINERY

It is estimated that there would have been no casualties to engineering personnel below decks. Casualties would have been very high among exposed personnel. Habitability was reduced by lack of steam power and general damage to the area exposed to blast pressure and fires.

ELECTRICAL

Electrical damage to living spaces were minor, except to CPO quarters aft, which was completely wrecked. The galleys could be used as soon as the main turbo generators were put in service following restoration of boiler power. The fire and flushing main was operable from diesel power immediately.

(e) Total effect on fighting efficiency.

HULL

The fighting efficiency of the INDEPENDENCE as an aircraft carrier has been reduced to zero.

MACHINERY

The effectiveness of this vessel as an aircraft carrier was reduced to zero, and could not be restored without a major overhaul.

ELECTRICAL

The fighting efficiency would have been zero due to the destruction of or damage to all aircraft handling facilities. Interior communications remained reasonably operable except for the 3 MC and 5 MC systems, which were largely inoperable or demolished.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

The gradation of damage on this ship illustrates the rapid deterioration of pressure as the wave moves out from the center of burst. Study of the ship suggests that had she been just a trifle closer to the burst, she would have been sunk; and, had she been just a trifle further away from the burst, she would have retained at least some, if not all, of her facilities as an aircraft carrier.

MACHINERY

It would appear that no aircraft carrier now afloat could withstand an attack of this nature at such close range without serious reduction of her military effectiveness as a carrier. Extensive studies of design features of this type are indicated.

ELECTRICAL

This vessel was subjected to the radiant heat of the bomb followed closely by air blast pressure of considerable magnitude. Due to the proximity of this ship to the bomb burst, the damage suffered was so extensive that it was rendered inoperable as a fighting craft.

The fact that ship's generators, both main and emergency, all switchboards, lights, automatic telephones, telegraphs and the announcing systems (except 3MC and 5MC) were all working in spite of the severe punishment received, certainly shows that the electrical equipment has been well designed to withstand battle damage.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

Future designs should eliminate structural discontinuities and provide compensation for all access openings, whether for doors, cables, vent ducts, or pipes. Frames should not be omitted in shell or blister panels. Stress concentrations, whether in corners of hatch openings, brackets, etc., should be reduced to the minimum. Circular vent ducts are preferable to rectangular sections. Door frames should be redesigned so that support will be provided by the panel stiffeners rather than the panel plating. Fifteen pound plating with adequate stiffening should be the minimum employed topside. Curved surfaces in lieu of flat should be used exclusively. Two bomb elevators should be provided in place of one. Automatic closure seals for bomb elevators, uptakes, and trunks should be studied. Overhanging structure and opportunities for the blast to "tunnel" should be eliminated. Vital services piping and cables should be kept below

decks even at the expense of convenience. Where this is not possible, they should be split and each branch protected by extra heavy structure, which should be streamlined. All topside operating positions should be completely enclosed, including gun and director stations, and should be streamlined. A study should be made of better methods of securing the elevators.

MACHINERY

Recommendations based on the experience of this vessel are too numerous for all to be listed here. A few of the most important will be mentioned in a general way.

1. Redesign stacks to enable them to better withstand blast pressure, and relocate them so all will not be badly damaged by blast pressure coming from one direction.

2. Study the design and layout of piping to make it better able to withstand this type of attack. In particular, support piping from heavy frames or other structural strength members not likely to fail or be severely distorted.

3. Adopt measures to prevent elevator platforms from being blown overboard or wrecked.

4. Reduce surface area of structural members of deck equipment (such as crane) as much as possible, and round these surfaces. Install the crane machinery in a protected location instead of on the rotating platform.

ELECTRICAL

For installation of electrical equipment such as power and lighting, distribution panels, transfer switches, motor controllers, distribution connections and junction boxes, and similar equipment supported on bulkheads less than 1/2 inch in thickness, "U" bracket foundations fabricated from flat bar and angle bar similar to enclosure sketches CR-1E and CR-2E, as recommended under part C, items F, G, K, and L should be used. When decks and bulkheads are deflected or buckled, the resultant stresses generated would then not be absorbed by the enclosures of the electrical equip-

ment, permitting a more flexible installation.

Cable should not be passed through long lengths of conduit and risers through decks should not be attached directly to fixtures, as bends in the conduit and shifting of equipment cause breaks in the cable. The last cable strap supporting the cable before it enters the equipment should be made of very light steel so as to permit it to fail when cable is tensioned.

The present method used to support the sensitive element in Mark VIII, Model 3, Arma compasses definitely will not withstand the effect of shock. It is recommended that the design of the flotation bowl and float be changed to incorporate some means of retaining mercury in the bowl when subjected to shock or rapid vertical acceleration. Use of a close fitting collar with baffles to suppress wave motion in the mercury is suggested. Bowl support springs between inner gimbal ring and outer bowl should either be increased in number or in size and a better method for securing them devised. Compasses on several of the target vessels had these springs greatly elongated or detached allowing the compass unit to fall to the base of the binnacle.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The LAMSON sank as a result of Test A. The time of sinking is not definitely known, but it is known that she disappeared sometime between the departure of the Technical Observer in PBM Charlie at 1400 and the arrival of the Director of Ship Material in his tour of the target array at 1700 on "A" day.

From the LAMSON's manner of capsizing (photo page 13) it is probable that the principal flooding source is somewhere on the unexplored starboard shell plating, amidships and near the test waterline. Divers report that the starboard garboard strake and port side bottom plating are intact along most of the ship's length.

(b) Structural Damage.

It appears that the stern was most badly damaged by the blast. This damage was undoubtedly aggravated by the manner in which the LAMSON pivoted on her stern when grounding as described in the underwater reports. As shown in photo page 16, by the discontinuity of the port sheer strake, the portion of the stern aft of frame 178 has twisted counterclockwise until the sheer strakes are separated by about three feet. This rotation appears to pivot about the centerline of the deck.

There is a large dent in the underwater shell (photo page 18) extending from the port propeller guard to the centerline. Divers report a wrinkle of 18 inch depth in the main deck plating at the stern.

Divers report a wrinkle of varying depth and width in the port side shell plating. It is 2.5 feet deep and 18 inches wide at frame 170 and tapers to nothing at frame 130. (photos page 16, page 21, and page 23). The port sheer strake appears crushed between frame 70 and 80 (see photo page 13).

There exists also the probable structural damage to the starboard side of the vessel as mentioned previously in the report. Since the ship is resting on the bottom on her starboard side, no examinations of this structure were possible.

All light structure topside appears to be badly damaged. One of the diver's impression was that some of the damage to the bridge may have been caused by grounding. The divers report both stacks are missing (photo page 12) and the foremast is bent aft 90 degrees at the signal bridge level. The foremast in photo, page 11, seem to be bent through an angle of 170 degrees.

The structure around the forward director is slightly damaged. The ship forward of the bridge is apparently intact except for the torn gun bucklers. At frame 70 a Z door and frame are blown out. The port side of the deck house aft of mount 2 is opened up top and bottom for a short distance fore and aft.

The torpedo tubes are apparently intact. Only one torpedo is in the tubes and it is broken and hanging there.

There are a large number of depth charges around the bottom aft. The special weapon NORD 5130 was not in its chocks on the stern and could not be located. The depth charge racks pictured in photo page 15 are torn and twisted almost beyond recognition.

(c) Other Damage.

Machinery and electrical damage were unobserved.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Unknown. Frame numbers and nameplates are still visible on the port side.

(b) Fires and Explosions.

Small fire in superstructure (See photo page 12).

(c) Shock.

Both stacks have been carried away, the foremast cannot be seen and much of the light superstructure appears to be missing (photo page 12). Her guns, however, can be seen at maximum elevation and are apparently undamaged.

(d) Pressure.

No damage attributed to this cause.

III. Results of Test on Target.

(a) Effect on Propulsion and ship control.

Unknown.

(b) Effect on gunnery and fire control.

The only source of information is photo page 12. The guns are visible at maximum elevation and apparently intact. The gun director is still in place.

(c) Effect on Watertight Integrity and Stability.

The explosion destroyed the vessel's watertight integrity and stability.

(d) Effect on Personnel and Habitability.

Unknown prior to time of capsizing and sinking.

(e) Total Effect on Fighting Efficiency.

Complete destruction.

IV. General Summary of Observer's Impressions and Conclusions.

Photographs of the burst taken from towers and planes, after-burst photographs of the array taken by PBM Charlie, the reports of the technical observer in PBM Charlie, the underwater photographs and the divers' report comprise the total source of information concerning this ship. A study of this information has been made and, although certain details were unobtained, the results are compiled here in an attempt to give the story of the ship from the time of explosion until she sank.

The explosion took place approximately 700 yards from and slightly forward of the beam of the LAMSON. Photo page 11 shows the LAMSON twelve seconds after the burst. The bridge structure, while erect, appears badly smashed. The guns are visible but the stacks, mast and light topside superstructure seem to have been swept away by the air blast. Photo page 12, the last tower picture of the LAMSON, was taken 5 minutes 42 seconds after burst. This gives another view of air blast damage and shows the LAMSON still erect.

When PBM Charlie reached the lagoon at approximately 0940 the LAMSON was lying over on her starboard side with her bridge structure under water (See photo page 13), and the port side of her bottom above the surface (See photo page 14). A large oil slick can be seen trailing to leeward. The LAMSON was sighted by the RECLAIMER when she re-entered the lagoon about 1300, and was still floating with her bottom barely visible when PBM Charlie left the lagoon at 1400. It has not been possible to determine the exact time the LAMSON disappeared. At approximately 1700 when the RECLAIMER made a quick tour of the lagoon there was no trace of the LAMSON.

The divers when making their underwater inspections found the wrecked LAMSON lying on her starboard side. The stern was

lying in a hole which makes it appear that the ship went down stern first, pivoted around and ended up heading southwest on the bottom.

V. Preliminary Recommendations.

Modification of design of superstructure, mast, and stack should be considered.

VI. Pre-test Statistics.

(a) Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel Oil	50%
Diesel Oil	50%
Ammunition	50%
Potable and Reserve Feed Water	95%
Salt Water Ballast	95%

Details of the actual quantities of the various items aboard are included in Report 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ship Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

The LAMSON at time of burst floated at drafts of 12' 0" forward and 12' 0" aft. She had a list of four degrees to starboard.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

No structural damage occurred in this ship as a result of Test A.

MACHINERY

No comment.

ELECTRICAL

Not observed.

(c) Other damage.

HULL

No damage was sustained by propulsion or other machinery.

MACHINERY

There is no damage to machinery of this vessel.

ELECTRICAL

There was no damage to electrical equipment.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat from the blast scorched slightly the outer layer only, of paint on vertical surfaces of the after side of the signal bridge, and of the after face of the deckhouse, frames 156-159. There was no scorching of fire hose, canvas, or manila.

MACHINERY

No evidence.

ELECTRICAL

There was some blistering of paint work on the vessel due to radiant heat from the blast.

(b) Fires and explosions.

HULL

There were no fires or explosions.

MACHINERY

No evidence.

ELECTRICAL

There were no fires or explosions on the vessel.

(c) Shock.

HULL

No shock effects were noted.

MACHINERY

No evidence.

ELECTRICAL

There were no effects of shock found in electrical equipment.

(d) Pressure.

HULL

The explosion bearing was approximately 170 degrees relati A sheet metal door of a damage control locker at frame 56 starboard, main deck, was perceptibly dished. Soot which had collected in the stacks was blown back into the firerooms and some dust was blown back through exhaust vents.

MACHINERY

No evidence.

ELECTRICAL

There were no effects of pressure found in electrical equipment.

(e) Effects peculiar to the atom bomb.

HULL

None, except heat.

MACHINERY

None.

ELECTRICAL

The scorching of painted surfaces by the radiant heat of the bomb is the only effect apparently peculiar to the atom bomb.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

HULL

None.

MACHINERY

None. All machinery on this vessel that was operable before Test A was operated after it, and functioned normally.

ELECTRICAL

None due to electrical damage.

(b) Effect on gunnery and fire control.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None due to electrical damage.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None due to electrical damage.

(d) Effect on personnel and habitability.

HULL

Habitability was not affected. Personnel in exposed topside locations probably would have suffered burns.

MACHINERY

None.

ELECTRICAL

None due to electrical damage.

(e) Effect on fighting efficiency.

HULL

None.

MACHINERY

None.

ELECTRICAL

None due to electrical damage.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Except for slight effect of heat, this ship was out of the damaging range of Test A.

MACHINERY

The CONYNGHAM was outside the effective range of the explosion in Test A.

ELECTRICAL

The vessel was very slightly affected by the blast. There was no damage. The lack of general damage indicate that no assumption as to the ruggedness of electrical equipment may be made based on the performance here.

V. Preliminary Recommendations.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

The web of frame 171 under the main deck is distorted slightly in way of a lightening hole. There is no other structural damage.

MACHINERY

No comment.

ELECTRICAL

No comment.

(c) Other damage.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

There was no damage whatever to any electrical equipment on the vessel.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation emanated from a point bearing about 170 degrees relative and at an elevation of about four degrees. There is slight scorching of paint on surfaces facing aft and to starboard. There is no scorching of canvas.

MACHINERY

None, except scorching and blistering of paint on exposed machinery.

ELECTRICAL

The only effect of heat noted was the slight scorching of paint on surfaces directly exposed to the blast.

(b) Fires and explosions.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

There were no fires and no explosions on the vessel.

(c) Shock.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

No effects of shock were found in any electrical equipment.

(d) Pressure.

HULL

Pressure caused elastic deflection of the main deck, aft, which stressed the supporting girders severely. Both flag bags are slightly dished and the uptake breeching is somewhat distorted.

MACHINERY

A staybolt on the starboard side of the uptake breeching pulled loose.

ELECTRICAL

No effect of pressure were found in any electrical equipment.

(e) Effects apparently peculiar to the atom bomb.

HULL

None.

MACHINERY

None.

ELECTRICAL

The only effect peculiar to the atom bomb found was a slight scorching of paint by radiant heat on surfaces exposed to the blast.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

Not observed.

MACHINERY

None. The ship was underway for two hours at speeds up to 10 knots after Test A. All machinery operable before the test was operated after it.

ELECTRICAL

Electrical damage caused no change in ship control. There is no electric propulsion on the vessel.

(b) Effect on gunnery and fire control.

HULL

Not observed.

MACHINERY

No comment.

ELECTRICAL

There was no change in gunnery or fire control caused by electrical damage.

(c) Effect on water-tight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

There was no change in water-tight integrity nor in stability caused by any electrical damage.

(d) Effect on personnel and habitability.

HULL

Exposed personnel probably would have been burned. There is no effect on habitability.

MACHINERY

None below deck.

ELECTRICAL

Electrical damage had no effect whatever on personnel nor did it change the habitability of the vessel.

(e) Total effect on fighting efficiency.

HULL

Except for the effects of heat and radioactivity there would have been no effect on fighting efficiency.

MACHINERY

None.

ELECTRICAL

The fighting efficiency of the vessel was in no way reduced by electrical damage.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

None.

MACHINERY

The MUGFORD was outside the effective range of the explosion in Test A.

ELECTRICAL

The only effect of the blast on the vessel was a slight scorching of paint work. The lack of any damage precludes any conclusions as to the ruggedness of electrical equipment on the vessel.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

None.

MACHINERY

None.

ELECTRICAL

As there was no damage, no recommendations are made.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There is no flooding and consequently no change in drafts or list.

(b) Structural damage.

HULL

There is slight dishing of the main deck between frames 147 and 179 with a permanent deflection of about 3/8 of an inch. This is accompanied by slight distortion of associated transverse and longitudinal girders and supporting stanchions. There is evidence of some increase during the test of previous damage to the shell plating on the starboard side and around the stern. The starboard and after bulkheads of the superstructure and deck houses are in general, slightly dished. This damage is intensified in the areas surrounding most weathertight doors which, together with their frames, are dished. Bulwarks of plating of 7# or less are generally damaged. The foremast bent forward and to port causing failure of the after starboard guys and of some antennae. Certain topside ladders are distorted.

MACHINERY

The stack, and the breeching between stack and uptakes, are dished and buckled, with numerous failures at riveted joints and several ruptures. The stack broke loose at its base on the starboard side, and is leaning to port. This motion of the stack caused buckling of the uptake breeching on the port side, below the joint between breeching and stack. The whistle and siren pulls are fouled.

ELECTRICAL

Not observed.

(c) Other damage.

HULL

No comment.

MACHINERY

Except for damage described under (b) above there is no damage to any part of the machinery installation. The vessel shifted berths under her own power after Test A, using speeds up to 10 knots. All machinery was operated at this time.

ELECTRICAL

There was no major electrical damage sustained by this vessel. The ship's service generators, emergency generator, and switchboards operated satisfactorily after the test. Minor electrical damage was sustained by:

1. Vent motor controller.
2. Running and anchor lights.
3. Lamps in main deck and superstructure spaces.
4. 36" searchlight.
5. Gyro repeater.
6. Announcing system reproducer.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Radiation came from about 150 degrees relative at an elevation of about 5 degrees. Paint on exposed surfaces is badly blistered and scorched. Paint on wood is more badly damaged than paint on steel. Paint damage extends not more than about .002 inches under the surface. Exposed signal halyards and life lines are scorched. The only other equipment affected are lines which are weakened slightly by scorching.

MACHINERY

Paint on deck machinery was scorched and blistered.

ELECTRICAL

The paint on all topside cables in the way of the short duration the heat blast was charred. The electrical characteristics of these cables were not impaired.

(b) Fires and explosions.

HULL

Fire damage is insignificant. One small fire has occurred in a life raft, frame 140, starboard. Apparently direct heat radiation penetrated a torn section of the canvas covering and burned a small part of the wood floater ring.

MACHINERY

No evidence.

ELECTRICAL

None observed.

(c) Shock.

HULL

There is no evidence of shock damage.

MACHINERY

No evidence.

ELECTRICAL

There was no conclusive evidence that this vessel experienced any large degree of shock. Some of the broken light bulbs might be attributed to shock.

(d) Pressure.

HULL

The apparent direction of the pressure wave is from a point about 150 degrees relative. Damage to hull structure due to pressure is minor and is limited to slight dishing of the main deck aft, slight dishing of superstructure bulkheads, bending of the foremast, distortion of the stack, and dishing of doors in the weather bulkheads. Light non-structural sheet metal structures are generally dished and distorted. The critical weight of topside plating appears to be 10 pounds. No damage to heavier plating was observed.

MACHINERY

Blast pressure, apparently from near the starboard beam, caused the damage described under I (b) above. Whipping motion of the vessel following the blast pressure apparently caused motion of the journals of the low pressure turbine (indicated by leads left in the bearing during the test) up to a maximum of .009 inch.

ELECTRICAL

The only evidence of pressure effects noted on electrical equipment, was the shattering of the 36 inch searchlight lens, and about 20 percent of the installed lamp bulbs.

(e) Effects apparently peculiar to the atom bomb.

HULL

Aside from radioactivity, the general extent and intensity of heat radiation is the only peculiarity noted.

MACHINERY

Blast pressure of this magnitude at this range from the blast is apparently peculiar to the atomic bomb.

ELECTRICAL

There were many instances where hatches and doors were dished in and torn from their mountings by the extreme force of the blast, however, the electric light lamps within these same spaces were undamaged.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

Not observed.

MACHINERY

Damage to the stack and uptake breeching reduces maximum boiler output somewhat (estimated at 10%). This reduces maximum speed of the ship by about 1 knot. The stack is greatly weakened and would have to be braced before the ship could steam in rough weather, or at high speed. High speed steaming is also impracticable with the ship in her present condition for the reason that stack gases escaping through the numerous openings near the main deck would be drawn into the ship's ventilation systems. It is estimated that temporary repairs could be made and temporary braces installed by the ship's force in approximately 2 days which would allow steaming at efficiency of 95% or higher for a limited time. It is estimated that approximately 6 days' work by a tender would be required to restore the stack and uptake breechings to normal.

Whistle and siren pulls could be cleared or new ones rigged by the ship's force within a short time.

ELECTRICAL

Damage to electrical equipment had no effect on the main electric plant or ship control.

(b) Effect on gunnery and fire control.

HULL

Damaged roller paths cause binding in train of the Mk 33 director and mounts.

MACHINERY

No comment.

ELECTRICAL

There was no effect on gunnery or fire control from electrical damage.

(c) Effect on water-tight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

Since there was no apparent failure of the below deck stuffing tubes, the watertight integrity of the vessel was not affected from an electrical viewpoint.

(d) Effect on personnel and habitability.

HULL

It is considered that topside personnel would have been badly injured by heat, blast, and radioactivity. Habitability has not been appreciably affected.

MACHINERY

It is not believed that there would have been any casualties among personnel below decks. Habitability is affected by the possibility of stack gases being drawn into the ship's ventilation systems. This would occur only if high speed were attempted. Otherwise, habitability was not affected by the test.

ELECTRICAL

There was no effect on habitability from electrical damage.

(e) Total effect on fighting efficiency.

HULL

The principal effects on the fighting efficiency of the ship are the injuries to personnel, the impairment of the director and mount 1, and the damage to antennae incident to the bending of the foremast. There is no impairment of strength or seaworthiness.

MACHINERY

The ship is limited to moderate speeds in good weather until after repairs to the stack and uptake breeching.

ELECTRICAL

There was no effect on the fighting efficiency of the vessel from electrical damage.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

This ship is not seriously damaged, however, the damage to antennae, the mast, the director and 5 inch mount 1 would prevent normal operation.

MACHINERY

The stack and the large flat, weak breechings between stack and uptakes, are obvious points of weakness against this form of attack. This fact is demonstrated also by the experience of the RHIND and HUGHES.

ELECTRICAL

The electrical damage on this vessel was confined to the main deck and above. This damage was so negligible that it had no effect on the habitability and fighting efficiency of the vessel.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

Attention should be given to the elimination of pocketed areas in the superstructure. More adequate protection should be given to personnel in gunnery and ship control stations.

MACHINERY

Stacks should be made more resistant to blast pressure. A study should be made with a view to eliminating or greatly modifying the present type of uptake breeching, which is common to most of our recent destroyers.

ELECTRICAL

It is recommended that consideration be given to the elimination of the 36" searchlight on this type vessel, since these searchlights are no longer used as originally intended, i.e. in conjunction with fire control. In the event these lights must be retained, it is considered that the design must be improved to withstand the excessive air blast. It is further recommended that exposed electrical equipment be reduced as much as possible to insure maximum protection against the heat and blast of the atomic bomb.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None.

(c) Other damage.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

This main generator plant, ship control, fire control and electrical equipment associated with gunnery were tested and operated satisfactory.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

The center of explosion bore approximately 310° relative. Blistering of paint occurred generally on surfaces facing to port. No scorching of manila or canvas occurred.

MACHINERY

No evidence.

ELECTRICAL

None other than slight blistering of paint in exposed areas.

(b) Fires and explosions.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

None.

(c) Shock.

HULL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None.

(c) Other damage.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

This main generator plant, ship control, fire control and electrical equipment associated with gunnery were tested and operated satisfactory.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

The center of explosion bore approximately 310° relative. Blistering of paint occurred generally on surfaces facing to port. No scorching of manila or canvas occurred.

MACHINERY

No evidence.

ELECTRICAL

None other than slight blistering of paint in exposed areas.

(b) Fires and explosions.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

None.

(c) Shock.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

None evidenced.

(d) Pressure.

HULL

The only effects of pressure are the tearing of deteriorated canvas on top of No. 3-5" mount, breakage of a glass port in the 5" Mark 33 director shield, and slight bending of the sun shield on a 20mm ready service box.

MACHINERY

No evidence.

ELECTRICAL

Negligable.

(e) Effects apparently peculiar to the atom bomb.

HULL

None, except that effects of heat.

MACHINERY

None.

ELECTRICAL

None, other than radiant heat.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

None.

MACHINERY

None.

ELECTRICAL

None.

(b) Effect on gunnery and fire control.

HULL

Essentially no effect. There is a broken glass port in the 5'' Mark 33 director top, over the rangefinder operator's station.

MACHINERY

No comment.

ELECTRICAL

None.

(c) Effect on water-tight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

Not observed.

(d) Effect on personnel and habitability.

HULL

Habitability was not affected. Personnel might have been affected by heat and by temporary blinding due to the intense light from the explosion.

MACHINERY

None.

ELECTRICAL

None except for radioactivity.

(e) Total effect on fighting efficiency.

HULL

The fighting efficiency was not affected, except that exposed topside personnel might have been affected by heat and light.

MACHINERY

None.

ELECTRICAL

None, other than wave phenomina.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

No comment.

MACHINERY

The MAYRANT was outside the effective range of the explosion during Test A.

ELECTRICAL

The location of this vessel was outside the effective range of the bomb.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

In general, all starboard and forward superstructure and deckhouse bulkheads are damaged. The extent of the damage varies from dishing to a depth of 1 1/2 inches in the cases of the midship and after deckhouse, to rupture of a bulkhead on the 02 level. All weather doors and light structures such as 20mm gun bulwarks, ladders, and catwalks on the starboard side of the ship are badly damaged.

The shell plating on the starboard bow is slightly dished with accompanying slight distortion of the webs of stiffening girders in way of lightening holes or cutouts.

The foremast and mainmast are bent aft and to port. All radio antennae are down. The antennae for most of the electronic equipment is distorted.

MACHINERY

The stack broke completely off about 4 feet above its base and fell over the port side. The stub stack remaining was torn apart at the starboard after corner. The breeching between uptakes and stack (above main deck) was badly crushed, and was ripped and torn on the starboard side.

ELECTRICAL

The forward bulkheads of the CIC room gave way causing damage to wiring and fittings secured to it and the steering tramsmitter in the pilot house above.

A bent frame in the starboard side of the after fireroom caused the compressor controller panel to crack.

(c) Other damage.

HULL

Not observed.

MACHINERY

The b ickwork of boiler #1 was severely damaged. Damage to stack and uptak breeching is described under (b) above. The steam line to whistle and siren, and the atmospheric exhaust pipe, which are attached to the stack, were bent into "U" shape and are hanging over the port side. The whistle and siren went overboard with their piping. The starboard motor whaleboat engine was badly damaged. Several nipples in small piping were broken.

ELECTRICAL

All electrical equipment other than radio and radar was operable except the 36" searchlight, the steering transmitter in the pilot house and a type "j" rotary switch in turret #2.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation emanated from about 50 degrees relative and at an elevation of about 15 degrees. Paint scorching is considerable and is more pronounced than blistering. Vertical surfaces showed

very slight scorching. Paint damage is confined to a depth of about .002 inches. Cordage and firehoses are considerably scorched where directly exposed to the radiation.

MACHINERY

Paint on the starboard side of deck machinery is scorched and blistered.

ELECTRICAL

Radiant heat was apparent from approximately 65 degrees relative. No damage to electrical equipment occurred other than the scorching of surfaces exposed.

(b) Fires and explosions.

HULL

Canvas bloomers on #1 and #4 gun mounts were completely burned.

A manila davit fall at frame 80, starboard, main deck, burned. It is believed that this ignited the gangway sea painter and lagging on the mainstay nearby. Fires were apparently caused by direct heat radiation. There were no explosions.

MACHINERY

No evidence.

ELECTRICAL

No fires or explosions occurred to electrical equipment.

(c) Shock.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

No shock was noted other than secondary shock caused by structural failures which is evidenced by the steering transmitter failure in pilot house.

(d) Pressure.

HULL

The direction of the pressure wave was from a point bearing about 60 degrees relative. The pressure wave caused slight dishing of the starboar shell and superstructure bulkheads, slight dishing of the starboard sides of gun shields, and moderate dishing of all weather doors. 5 pound bulwarks around 20mm guns on the starboard side are damaged. The stack is missing. The uptakes are heavily distorted. The foremast is bent aft and to port. Light nonstructural sheet metal structures are generally badly damaged where exposed.

MACHINERY

A heavy blast pressure struck the ship from the starboard side. This and the resultant whipping motion of the ship caused all the damage described above.

ELECTRICAL

Slight damage to electrical equipment by pressure was noted at the 36'' searchlight, also in way of cables on the mast and the collapsing of the CIC bulkhead which affected the steering transmitter.

(e) Effects peculiar to the atomic bomb.

HULL

Radioactivity and the intense heat are the only effects peculiar to the atom bomb.

MACHINERY

A blast pressure of this magnitude is apparently peculiar to the atom bomb.

ELECTRICAL

No effects to electrical equipment were apparent.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

HULL

Not observed.

MACHINERY

Boiler #1 is inoperable. Repairs to brickwork could be made by the ship's force in about 3 days. All other damage to machinery is minor and would not affect operation. Damage to the stack would prevent operation except at low speed and under favorable wind conditions, because of stack gasses entering the engine room... ventilation. Emergency repairs to the uptakes breeching and the stub stack requiring about 1 day would improve this condition, but not sufficiently to permit normal operation. The atmospheric exhaust line, which was bent over and flattened, had to be punctured to allow steaming of any boiler.

ELECTRICAL

No effect occurred to electrical machinery. Slight damage occurred to ship control in the way of the pilot house steering transmitter.

(b) Effect on gunnery and fire control.

HULL

Not observed.

MACHINERY

No comment.

ELECTRICAL

No electrical effect on gunnery occurred.

Slight effect on fire control occurred due to the casualty to the 36" searchlight.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

No electrical effect on watertight integrity and stability occurred.

(d) Effect on personnel and habitability.

HULL

The habitability is unimpaired.

MACHINERY

It is not believed that there would have been any casualties among personnel below decks. Exposed personnel would have suffered heavily. The test had no appreciable effect on habitability except for the effect of stack gasses drawn into the ventilation system (see "a" above).

ELECTRICAL

No effect occurred due to electrical damage.

(e) Effect on fighting efficiency.

HULL

The principal effects on fighting efficiency result from loss of the stack and failure of the masts. The latter would render most of the electronic equipment inoperable.

MACHINERY

Damage to the stack and to #1 boiler greatly reduced the vessel's ability to steam and limited courses she could steer to those providing favorable wind conditions. It is estimated that approximately 20 days work at a shipyard would be required to restore normal operating conditions.

ELECTRICAL

Effect on fighting efficiency by electrical damage was negligible being confined to the 36'' searchlight.

IV. General Summary of Observers Impressions and Conclusions.

HULL

The most serious effect of the hull damage is the failure of the foremast with its accompanying damage to the electronics antennae. This damage to antennae renders the electronic equipment inoperable. The general failure of all weather deck doors, even in areas where surrounding bulkheads suffered little distortion, is particularly noticable.

MACHINERY

The vulnerability of the stacks and the breeching between uptakes and stacks are on obvious point of weakness.

ELECTRICAL

All electrical damage was light and could be repaired by the ship's force except the 36" searchlight. This ship could accomplish regularly assigned missions.

V. Preliminary Recommendations.

HULL

The necessity for attention to the design of stacks, masts, doors and aluminum structure is apparent.

MACHINERY

The stack should be made more resistant to blast pressure. The breeching between stack and uptakes should be redesigned or eliminated, as it offers little resistance to blast pressure.

ELECTRICAL

Recommendations are included with each individual item in part C, where applicable.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test, general areas of flooding, sources.

No flooding occurred in this ship, consequently there was no change in draft or list.

(b) Structural Damage.

HULL

Structural damage is superficial. Panel dishing of weather bulkheads and doors occurred above the main deck level, principally in bulkheads facing to starboard. Maximum dishing is of the order of three inches. Local dishing of the starboard shell palting above the waterline occurred to a maximum depth of one inch. In way of shell dishing, framing is distorted at frames 10, 21, 32 82, 86 and 122. Some damage occurred to rigging, antennae and halyards. The stack breeching is dished and torn.

MACHINERY

A few seams were opened in the outer casing of the breeching between stack and uptakes, above the main deck. This does not impair operation.

ELECTRICAL

No structural damage to electrical equipment occurred.

(c) Other damage.

HULL

No comment.

MACHINERY

About 50% of the lagging was torn off the steam supply line to the whistle and siren, above the main deck. This does not impair operation. There is no other damage to machinery.

ELECTRICAL

No damage to electrical machinery, ship control or fire control occurred.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat come from a bearing of approximately 22 degrees relative. Scorching of paint work and manila lines is heavy and in some cases reached the ignition point, as evidenced by smoke smudges. Gun bloomers, life raft covers, and fire hoses are scorched.

MACHINERY

Paint on exposed machinery was scorched and blistered.

ELECTRICAL

Radiation came from about 45° relative. Slight damage was done to painted surfaces of exposed cable and searchlight train and elevation indicator dial glasses by scorching.

(b) Fires and explosions.

HULL

No explosions occurred. Flag halyards, the anchor ball, pilot house windshield wipers, and degaussing cables burned.

MACHINERY

No evidence.

ELECTRICAL

No fires or explosions occurred.

(c) Shock.

HULL

Shock effect is slight. Some electronics damage occurred in Radio Control. A rangefinder stable element was jarred out of its gimble forks. Power fuses in the pilot house jumped out of clips. Ammunition fell from gun bulwark ready racks.

MACHINERY

No evidence.

ELECTRICAL

No damage by shock to electrical equipment occurred.

(d) Pressure

HULL

Blast pressure came from approximately 22 degrees relative. Panel dishing of weather bulkheads occurred to plating 3/16 inch in thickness. Light dishing of the starboard shell occurred in plating varying in weight from nine pounds to fourteen pounds.

MACHINERY

Blast pressure opened a few seams in the outer casing of the uptake breeching, and tore off part of the lagging on the steam line to the whistle and siren. The blast came from starboard.

ELECTRICAL

Slight electrical damage occurred as follows:

The special code 660 material, PAE speaker amplifier box collapsed from external pressure.

(e) Effects peculiar to the Atom Bomb.

HULL

The only effect apparently peculair to the Atom Bomb is that of extreme heat.

MACHINERY

Blast pressure slight enough to have noticeable effect at such a distance from an explosion is apparently peculiar to the Abom Bomb.

ELECTRICAL

None other than radioactivity.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

Propulsion and auxiliary machinery remains undamaged. Electrical and ship control equipment is essentially unaffected.

MACHINERY

None. The ship changed berths under her own power after Test A, at which time all machinery was operated, and functioned normally.

ELECTRICAL

No damage occurred.

(b) Effect on gunnery and fire control.

HULL

Gunnery and fire control equipment are affected only to a very slight degree. Some damage occurred to gun director and rangefinder shields.

MACHINERY

No comment.

ELECTRICAL

No damage occurred electrically.

(c) Effect on watertight integrity and stability.

HULL

Watertight integrity and stability are not affected.

MACHINERY

No comment.

ELECTRICAL

No effect occurred due to electrical equipment.

(d) Effect on personnel and habitability.

HULL

Exposed topside personnel, as well as those in the main director and possibly CIC, probably would have been killed by the blast. Personnel in the forward 5''/38 gun shields, pilot house, and radio room would possibly have been badly injured.

MACHINERY

None below decks.

ELECTRICAL

No effect occurred due to electrical equipment.

(e) Effect on fighting efficiency.

HULL

Fighting efficiency would have been impaired only in proportion to the extent of injuries to personnel.

MACHINERY

None.

ELECTRICAL

No effect on fighting efficiency occurred due to electrical equipment.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

At the distance of this vessel from an Atomic Bomb blast, panel dishing of structure, damage to miscellaneous top side gear, and serious casualties to exposed personnel can be expected.

MACHINERY

The STACK was outside the effective range of the explosion in Test A.

ELECTRICAL

This vessel, due to distance from the blast suffered no major damage and could have carried out its mission as a fighting ship.

V. Preliminary General or Specific Recommendations of Inspection Group.

HULL

More adequate protection from the effects of air blast and heat is needed for topside personnel. Improvement in the strength of doors, and stiffening of flat surfaces in the vicinity of such openings, is indicated. Provision should be made for more adequate securing of miscellaneous topside gear such as ladders, flag bags, and air port lenses. Weather bulkheads and gun bulwarks should be constructed of not less than 10 pound plate.

MACHINERY

None.

ELECTRICAL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There is no flooding, consequently no change in drafts or list.

Draft before and after Test:

Forward, 12' 6"; Aft 11' 1"; List 0°.

(b) Structural Damage.

HULL

Structural damage is confined principally to superstructure areas forward of amidship facing to starboard and to the starboard shell plating. The stack breeching is damaged by blast pressure. The starboard flag bag was blown from its securing clips. Dishing of the starboard shell occurred between the main and forecastle decks, frames 40 to 69, and resulted in failure of web frame 52. The starboard shell is dished also from the main deck down approximately 6 feet, frames 72 to 76. Maximum depth of shell dishing is 3 inches in the forward area and 2 1/2 inches in the amidship area. A moderate degree of irregularity of shell plating is general throughout and is believed to be the result of normal operating conditions. Damage to the shell does not significantly affect the longitudinal strength of the ship.

Longitudinal weather bulkheads facing to starboard are dished on the navigating bridge, superstructure deck and forecastle deck. Dishing of superstructure bulkheads reaches a maximum of 2 inches in way of the CIC Room, frames 57 1/2 to 64. Doors and door frames in the superstructure are dished generally on the starboard side.

MACHINERY

A crack in the breeching between uptakes and stack above main deck, starboard side, which existed before Test A, was lengthened. The outer casing of the breeching was moderately dished on the starboard side. The whistle pull was broken.

ELECTRICAL

There was no structural damage in way of electrical equipment.

(c) Other damage.

HULL

No damage occurred to machinery, or to ship control, fire control, or gunnery equipment. Vertical radio antennae were carried away by the falling starboard flag bag.

MACHINERY

Except for the inconsequential damage mentioned in I (b) above, there was no damage to machinery of this vessel during Test A.

ELECTRICAL

No damage occurred to electrical equipment due to Test A.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

The source of heat radiation bore approximately 30 degrees relative. Paint is scorched on surfaces facing forward or to starboard, and the forecastle deck plating is scorched. All exposed lines are scorched, old line being damaged to a greater degree than new.

MACHINERY

Paint on exposed machinery was scorched and blistered.

ELECTRICAL

No evidence of heat in way of electrical equipment.

(b) Fires and explosions.

HULL

No explosions occurred in this ship. A fire occurred in kapok life jackets stowed on the forward side of a gun bulwark, frame 126, starboard.

MACHINERY

No evidence.

ELECTRICAL

There were no fires or explosions in way of electrical equipment.

(c) Shock

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

There was no evidence of shock in way of electrical equipment.

(d) Pressure.

HULL

Blast pressure came from an angle of approximately 30 degrees relative. Structure yielding under the effects of blast are aluminum weather bulkheads, doors, and door frames in the superstructure, light steel bulwarks, and areas of the starboard shell plating forward of amidship. Aluminum bulkheads and steel bulwarks of less than 1/4 inch thickness suffered panel dishing.

MACHINERY

Blast pressure lengthened an already existing crack in the breeching between uptakes and stack above the main deck, moderately dished the outer casing of the breeching, and broke the whistle pull. The blast came from starboard.

ELECTRICAL

There was no evidence of pressure in way of electrical equipment.

(e) Effects peculiar to the Atom Bomb.

HULL

The only effect peculiar to the Atom Bomb is the intense heat.

MACHINERY

Blast pressure sufficient to have a noticeable effect at this distance from an explosion is apparently peculiar to the Atom Bomb.

ELECTRICAL

Radiant heat and radioactivity were evident on exposed surfaces. There was no damage to electrical equipment due to these effects.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

HULL

Not observed.

MACHINERY

None. All machinery that was operable before Test A was operated after it, and functioned normally. The ship shifted berths under her own power after Test A.

ELECTRICAL

No damage was apparent to electrical machinery or ship control.

(b) Effect on gunnery and fire control.

HULL

Not observed.

MACHINERY

No comment.

ELECTRICAL

No damage apparent.

(c) Effect on watertight integrity and stability.

HULL

Not observed.

MACHINERY

No comment.

ELECTRICAL

No electrical damage affected watertight integrity or stability.

(d) Effect on personnel and habitability.

HULL

Habitability is unaffected. Personnel in exposed locations would have suffered casualties from the intense heat of the bomb explosion and possibly from the blast.

MACHINERY

None below decks.

ELECTRICAL

No electrical damage affected personnel or habitability.

(e) Effect on fighting efficiency.

HULL

Fighting efficiency is essentially unimpaired by the Test. A temporary lapse of communication would have resulted from the loss of radio antennae.

MACHINERY

None.

ELECTRICAL

No electrical damage affected the fighting efficiency of the vessel.

IV. General Summary.

HULL

Damage to this ship is superficial. Deflection of bulkheads and shell plating is not sufficient to impair the strength of the ship.

MACHINERY

The WILSON was outside the effective range of the explosion during Test A.

ELECTRICAL

No damage was evident on any electrical equipment on this vessel. It appears that the effects of the A bomb at the distance of this vessel from the center of the blast require no special precautions or designs for electrical equipment.

V. Preliminary Recommendations.

HULL

Plating less than 1/4 inch in thickness should not be used in superstructure locations exposed to blast pressure of this magnitude. Inasmuch as shell plating appears vulnerable to blast pressure at this range, attention should be given to shell plating weights used in new designs. Web frames and shell longitudinals should be of adequate scantlings and lightening holes and cut-outs for longitudinals should be eliminated. Topside fittings, such as flag bags, should be more securely attached to the ship's structure. Flag bags, as at present designed, are too light to withstand the effects of blast.

MACHINERY

None.

ELECTRICAL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There is no flooding and consequently no change in drafts or list.

(b) Structural damage.

HULL

In the superstructure, metal joinerwork is buckled and furniture and equipment are disarranged. Most watertight and weathertight doors and door frames above the main deck are distorted sufficiently to make them incapable of fulfilling their designed function and to seriously impede access to the spaces involved. The main mast is broken off just below the yard arm. The foremast is bowed forward slightly, and all connected antenna are carried away. The stack is dished but is intact. Uptakes are badly dished with some separations in the outer casing.

Damage to the hull is confined to moderate buckling of the main deck between frames 172 and 184. This is accompanied by a slight distortion of the associated transverse and longitudinal structural members and supporting stanchions.

There is no apparent damage to the compartments below the waterline.

MACHINERY

Breeching between uptakes and stack was severely dished and ruptured in places. The stack was considerably wrinkled and dished.

ELECTRICAL

No comment.

(c) Other damage.

HULL

No comment.

MACHINERY

The air casings of all boilers were blown out, damage being concentrated largely on rear casings. There was some other damage to boilers (fuel oil burners and brickwork). Structural damage occurred to the stack and the breeching between uptakes and stack. The compressed air line to the torpedo workshop was broken by the distortion of a bulkhead.

ELECTRICAL

The electric plant on this vessel suffered negligible damage. The 36'' searchlight and two (2) flood lights mounted on the topside of the vessel were the only electrical equipment to be damaged by the blast.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation came from about 200° relative and at an elevation of about 13°. Exposed vertical surfaces have suffered much more than similarly exposed horizontal surfaces. Heat penetration on paint is only through one coat, or about 0.002 inches. Scorching on cordage is only a few hundredths of an inch deep. No structure or equipment is impaired as a result of heat.

MACHINERY

Not evidenced on machinery or in machinery spaces, except scorching of paint in exposed areas.

ELECTRICAL

The heat of the Atomic Bomb blast charred paint on exposed cable and topside electrical equipment. However, the electrical characteristics of this equipment were not impaired. The heat radiation appeared to have originated from the port quarter of the vessel.

(b) Fires and explosions.

HULL

One minor fire occurred in a mattress located on the port side of the fantail and used as chaffing gear for the stern mooring cable. The cause of ignition is believed to be direct heat radiation that penetrated the thin cotton covering and ignited the cotton batting. No damage resulted from the fire other than the burning of paint in the immediate area.

MACHINERY

Not evidenced.

ELECTRICAL

There was no electrical damage as a result of fires or explosions.

(c) Shock.

HULL

There is no evidence of shock damage.

MACHINERY

No evidence.

ELECTRICAL

The electrical equipment on this vessel was not apparently subjected to any shock.

(d) Pressure.

HULL

All of the exposed surfaces of the ship above the water-line showed evidence of blast. The pressure wave emanated from a point bearing about 200° relative and at an elevation of about 13°. The major areas of damage as a result of pressure are the after bulk-heads of the forecastle structure, the stack, the uptakes, the masts, and the main deck aft between frames 172-184. The failures consist principally of moderately dished and distorted structure, particularly doors, except in the very light plating of the uptakes where joints are opened and stay bolts have pushed through. The critical thickness of topside plating is in the neighborhood of 10# medium steel since heavier plating is apparently undamaged.

MACHINERY

Blast pressure caused all machinery damage.

ELECTRICAL

All topside electrical damage in this vessel can be attributed to the pressure of the blast. The 36# searchlight and two (2) floodlights were severely damaged by this pressure.

(e) Effects apparently peculiar to the Atom Bomb.

HULL

With the exception of radioactivity, the intensity of heat was the only peculiarity observed.

MACHINERY

Blast pressure of this magnitude at this range from an explosion appears to be peculiar to the atom bomb.

ELECTRICAL

Although many hatches and doors were dished in and torn from their mountings by the extreme pressure of the blast, the lighting fixtures and lamps within the compartments, within the immediate vicinity of this damage, were undamaged. This phenomena was probably due to the heavy and relatively slow acting blast wave which seems to be characteristic of this weapon.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

HULL

No comment.

MACHINERY

All steam power was lost because of damage to the boilers and breeching between uptakes and stack. Damage to the stack, while altering the appearance of the ship, would not impair operation. The effect of the damage on ship control was to reduce the power available to that furnished by the emergency diesel generator.

ELECTRICAL

Propulsion and ship control of this vessel was not affected by electrical damage on this vessel.

(b) Effect on gunnery and fire control.

HULL

No comment.

MACHINERY

No comment.

ELECTRICAL

Gunnery and fire control on this vessel was not affected by damage to electrical equipment on this vessel.

(c) Effect on watertight integrity and stability.

HULL

There is no evidence of flooding and since the weight of displaced topside structure is negligible, there is no apparent effect on stability. Watertight boundaries and closures below the weather deck are intact. The watertight doors on the main deck just forward of the break in the forecastle deck, port and starboard, are badly distorted, destroying the integrity of bulkhead 61 above the main deck. This could cause minor flooding in heavy seas.

MACHINERY

No comment.

ELECTRICAL

Since there was no apparent damage to cable stuffing tube areas, the watertight integrity was not affected from an electrical viewpoint.

(d) Effect on personnel and habitability.

HULL

The damage to the ships structure has little effect on personnel. The protection afforded topside personnel by splinter shields and gun tubs is inadequate. Inasmuch as there are no major structural failures in interior spaces and equipment and furniture are still intact, there is no reduction in habitability.

MACHINERY

Some casualties to fireroom personnel might have occurred from lethal gases escaping from the ruptured boilers. No flarebacks would have occurred with this type of boiler. No other casualties would have occurred among personnel below decks, but casualties among exposed personnel would have been high. Habitability would have been reduced by loss of steam power.

ELECTRICAL

There was no effect on the habitability of this vessel from electrical damage.

(e) Total effect on fighting efficiency.

HULL

The failure of the masts and consequent destruction of antenna would have rendered inoperable a considerable amount of electronic equipment. There is no effect on the structural strength. The principal effect on seaworthiness is the damage to weather doors which would permit entry of water in a seaway.

MACHINERY

The ship was immobilized. It is estimated that emergency repairs to enable the ship to steam at slow speed on one boiler could be made under war conditions in approximately five days by the ship's force,

or in 60 hours by a tender. It is estimated that at least 40 days work at a naval shipyard would be required to restore the plant to full operating condition.

ELECTRICAL

There was no effect on the fighting efficiency of this vessel from electrical damage.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

Detailed investigation indicates that the structural damage is almost entirely confined to light structure of 10# plating or less and to access closures and has occurred as a result of blast.

MACHINERY

The test demonstrated the vulnerability of the casings of these boilers to this type of attack.

ELECTRICAL

The electrical damage to this vessel was limited to the topside area, occurring primarily in those instances where there was excessive hull distortion and failure. Damage to the 36" searchlights and floodlights resulted from the pressure of the blast. It appears that this vessel was subjected to a fairly high pressure, however, very little acceleration was imparted to this vessel or its equipment. This probably accounted for the small amount of shock damage noted on this vessel.

V. Preliminary Recommendations.

HULL

The nature of damage sustained by this vessel indicates the necessity for a redesign of exposed surfaces with a view towards increasing their resistance to external pressure. Topside structure

should be faired into integral units, eliminating pockets, recesses and open passageways. The use of open, or partially protected, stations should be avoided. Access and ventilation closures should be redesigned to overcome apparent weaknesses.

MACHINERY

Boiler casings should be strengthened to increase their resistance to blast pressure.

ELECTRICAL

It is recommended that consideration be given to the elimination of the 36" searchlights on this type vessel, since these searchlights no longer are used as originally intended; i.e., in conjunction with fire control. In the event these lights must be retained, it is recommended that the use of cast aluminum equipment be completely avoided. The searchlight yoke should be strengthened considerably and made from fabricated steel. Castings should be avoided. Base mounting and kingpin arrangement appears to be a weak point in the design of this particular searchlight and should be improved. It is recommended that exposed electrical equipment be reduced as much as possible to insure maximum protection against the heat and blast of the atomic bomb. Where this equipment must be exposed, it should be adequately covered with paint to insure protection against the heat of the blast.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding sources.

The ANDERSON sank approximately seven minutes after the blast. The probable source of flooding was located amidships, port side.

(b) Structural damage.

The explosion, as seen in photos Page 16, Page 17, and Page 18, followed by an immediate capsizing to port, indicates structural damage to the port side amidships. Since all photographs taken after damage were of the starboard side, there is no confirmatory evidence available.

Subsequent underwater inspections disclosed that the starboard side of the hull was wrinkled at frame 70 as shown in photos Page 31 and Page 33.

The main deck was also wrinkled at frame 40. Several seams along the starboard side were leaking oil and air. The divers' reports mention no other damage to the hull structure.

The bridge structure, midships deck house and after deck house are severely damaged. Bulwarks and lifelines on several decks were bent or torn off the ship as evidenced in photos, Page 28, Page 30 and Page 38. It is uncertain as to whether the torn and buckled bridge damage was caused by air blast or grounding. This uncertainty likewise applies to the mainmast. Though found erect and still on the ship, the mainmast was found stripped of many fittings and with its yard-arm snapped in half (See photos, Page 39 and Page 40.) The radar antenna and stack are missing. Divers report a number of pieces of corrugated aluminum joiner bulkheads.

on the bottom of the lagoon near the port side of the wreck. The number 2 gun shield is split open and badly mangled. However, the gun itself is intact and apparently undamaged. Both 5" guns aft were undamaged. The starboard torpedo tubes, though missing torpedoes, appear intact. All eight torpedoes, which had been previously loaded in the tubes, were free of the tubes but found near the ship by the divers. On three of the torpedoes the air flasks were crushed. It is noted in photo, Page 35 that the torpedo crane has been bent through an angle of about 90°. The starboard "Y" guns were missing. There was a hole in the deck where one of the guns had been.

(c) Other damage.

Damage to machinery and electrical systems not observed.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No information obtained. Frame numbers and ships name were clearly visible on the starboard side of the ANDERSON.

(b) Fires and explosions.

The first explosion occurred at burst plus 9 seconds as seen in photo, Page 12.

A second explosion occurred at a clock time of 0903:01 as seen in photos, Page 16, Page 17 and Page 18 . Each explosion caused a fire amidships on the port side. The divers who inspected only the starboard side of the ship's hull report no evidence of any explosion.

(c) Shock.

The stack was blown off (See photo, Page 14), number two gun shield split open, and both deck houses crumpled.

Underwater inspection showed that the SG and SC search radar antennas (See photos, Page 39, and Page 40), the gun director (See photo, Page 42) and the MK 4-22 fire control radar antenna (See photos, Page 41 , and Page 42), were clear of the ship. They are probably blast damage. However, this damage also could have been caused by grounding. Similarly, damage to the foremast (See photos, Page 39, and Page 40), and bridge, and the starboard hull wrinkles (See photos, Page 31, and Page 33), could have resulted from either air blast or grounding. In addition to local damage it was noted from radar pictures and tower pictures that the ANDERSON was blown outward a distance of a hundred yards before sinking.

(d) Pressure.

No damage attributed to this cause.

III. Results of Test on Target.

(a) Effect on propulsion and ship control.

Unknown.

(b) Effect on gunnery and fire control.

Fire control, both radar and optical, entirely inoperative. The five inch guns were apparently undamaged but damage to their minor components probably rendered them below normal if operative at all.

(c) Effect on watertight integrity and stability.

Complete destruction.

(d) Effect on personnel and habitability.

Unknown, except for the hazards of a sinking ship.

(e) Total effect on fighting efficiency.

Sunk.

IV. General Summary of Observer's Impressions and Conclusions.

Photographs of the burst taken from towers and planes, after burst photographs taken of the array from PBM Charlie, the reports of the technical observer in PBM Charlie, the underwater photographs, the Bureau of Ships, Interim Report, and the divers' report are the total available sources of material. A study of this information has been made and, although certain details were unobtained, the results are compiled here in an attempt to give the story of the ships from the time of bomb burst to the time of sinking.

The first information on the ANDERSON is obtained from photo, Page 12, which shows twin explosions occurring 9 seconds after the burst. The ARDC 13 can be seen below the left explosion. Study of the target array and explosion pictures from other towers position the second explosion directly over the ANDERSON. The spoon of a destroyer torpedo tube was found on the ARDC 13 which was approximately 200 yards relative bearing 70° from the ANDERSON (The divers' report failed to add to this information).

An early picture of the ANDERSON, as she emerges from the smoke, is shown in photo, Page 13. Her stack is missing and the inception of a fire can be seen just abaft the bridge. This picture was taken at a clock time of 0901:25. From this time until her capsizing and subsequent sinking the ANDERSON is visible continuously on timed photographs from various angles. Significant frames from two of the best sequences are included here.

Photo, Page 14, the first in the aerial sequence, was taken at a clock time of 0902:45 (Although burst time is not recorded for these clocks it is estimated to be approximately 0900:35). The fire has reached its maximum intensity.

Photo, Page 15, taken at a clock time of 0902:55, shows that the fire has subsided. Six seconds later, see photo, Page 16, clock time 0903:01, the burning flares up again and in twenty seconds the ANDERSON begins to capsize (See photos, Page 17, and Page 18).

It appears that a low order explosion has occurred which caused or materially aided the ANDERSON's capsizing. Photos Page 18, Page 19, and Page 20, indicate that the ANDERSON capsized in approximately 15 seconds.

Photo Page 21, clock time 0906:10, indicates the ANDERSON remained afloat for approximately two and a half minutes after she capsized.

Photos, Page 22, Page 23, Page 24, and Page 25, give the capsizing sequence as photographed from Enyu Tower. This set has the advantage that the bomb burst was photographed and times can therefore be given in minutes after burst instead of clock time. Photo Page 22 , shows her at burst plus 2 minutes 45 seconds in the process of capsizing, photo Page 23, burst plus 2 minutes 51 seconds, shows the turn of the bilge and capsizing complete. At burst plus 4 minutes the ANDERSON is settling as seen in photo Page 24 . In photo Page 25 , the ANDERSON's stern has disappeared and her bow is visible under the forward kingpost of the listing CARLISLE. Complete submergence occurs at burst plus 6 minutes 57 seconds.

Photos, Page 26, and Page 27, are of the array as seen on an APQ-7 radar scope. In photo Page 26 , the ANDERSON is seen just above the arrow. Photo Page 27, burst plus 2 minutes 38 seconds, is the first frame without an ANDERSON pip. This time corresponds with the capsizing of the ANDERSON, not her sinking.

The divers reported the ANDERSON lying on her port side in about 176 feet of water. The bow of the ship was buried in the bottom up to the main deck back to frame 17 port. The starboard side of the vessel was visible almost to the bow. The stern of the vessel was estimated to be about 15 feet from the lagoon bottom. Off her starboard quarter a large quantity of 40MM ammunition was strewn about the bottom. The ship was reported to be in one piece. The underwater photographs in general, need no further comment. Photos, Page 28, Page 29, and Page 34, however, show that the superstructure, although heavily damaged, was not demolished.

V. Preliminary Recommendations.

(a) Modification of superstructure, mast and stack design should be considered.

(b) Modification of radar installations topside should be considered.

VI. Pre-test Statistics.

(a) Instructions for loading the vessel specified the following:

ITEM	LOADING
Fuel Oil	95%
Diesel Oil	95%
Ammunition	100%
Potable and Reserve Feed Water	95%
Salt Water Ballast	None

Details of the actual quantities of the various items aboard are included in Report No. 7, Stability Inspection Report, submitted by the ship's force in accordance with "Instructions to Target Vessels for Tests and Observations by Ship's Force" issued by the Director of Ships Material. This report is available for inspection in the Bureau of Ships Crossroads Files.

The ANDERSON at time of burst floated at drafts of 13' 3" forward and 12' 6" aft. She had a list of two degrees to port.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

Not observed.

(c) Other damage.

HULL

No damage occurred to propulsion or other machinery.

MACHINERY

There was no damage to machinery during test A.

ELECTRICAL

None.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

The explosion bore approximately 186 degrees relative. Exposed transverse bulkheads facing aft suffered moderate scorching and blistering of paint.

MACHINERY

No evidence.

ELECTRICAL

The sole evidence of heat was the slight blistering of painted surfaces exposed directly to the blast. This blistering was not great enough to affect in anyway the electrical cable and equipment exposed.

(b) Fires and explosions.

HULL

None.

MACHINERY

No evidence.

ELECTRICAL

There were no fires or explosions.

(c) Shock.

HULL

No effects noted.

MACHINERY

No evidence.

ELECTRICAL

There was no evidence of shock in any electrical equipment.

(d) Pressure.

HULL

The port and starboard flag bags are dished approximately one inch. A ventilation duct seam opened in the electrical workshop, B-103-E.

MACHINERY

No evidence.

ELECTRICAL

There is no evidence of pressure.

(e) Effects peculiar to the atom bomb.

HULL

None, except that of radioactivity.

MACHINERY

None.

ELECTRICAL

None.

III. Results of Test on Target.

(a) Effect on machinery, electrical, and ship control.

HULL

None.

MACHINERY

Test A had no effect on machinery, and had no effect on ship control insofar as machinery is concerned.

ELECTRICAL

No effect noted by inspection and operation.

(b) Effect on gunnery and fire control.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

None.

(d) Effect on personnel and habitability.

HULL

Habitability is unaffected. Personnel in exposed topside locations probably would have suffered burns and temporary blindness.

MACHINERY

Test A would have had no effect on personnel below decks. It had no effect on habitability insofar as machinery is concerned.

ELECTRICAL

None.

(e) Effect on fighting efficiency.

HULL

None, except through possible injury to topside personnel in exposed positions.

MACHINERY

None.

ELECTRICAL

None.

IV. General Summary of Observers' Impressions and Conclusions.

HULL

This ship was outside of the structural damage range but within the probable personnel injury range.

MACHINERY

The MUSTIN was outside the effective range of the explosion in Test A.

ELECTRICAL

The vessel was located too far out from the point of explosion to receive sufficient damage.

V. Preliminary Recommendations.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

No recommendations are made.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; general areas of flooding, sources.

There was no flooding, hence no change in drafts or list.

(b) Structural damage.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

There was no structural damage in way of electrical equipment.

(c) Other damage.

HULL

Not observed.

MACHINERY

The machinery was not damaged by Test A.

ELECTRICAL

No damage occurred to electrical equipment due to Test A.

II. Forces Evidenced and Effects Noted.

(a) Heat.

HULL

Heat radiation emanated from about 320° relative and an elevation of about 4°. It caused scorching and blistering on vertical painted surfaces normal to the burst. There is some scorching of canvas and cordage.

MACHINERY

Not evidenced.

ELECTRICAL

No evidence of heat in way of electrical equipment.

(b) Fires and Explosions.

HULL

There were no explosions. Fires burned the painted canvas gun bloomers on mounts, 1, 2, and 4 and the canvas cover on the starboard side of the 5 inch battery director, and an unpainted canvas cover on an animal cage at frame 10, port. All fires are considered to have been caused by heat radiation. These fires caused no damage to structure or other equipment.

MACHINERY

Not evidenced.

ELECTRICAL

There were no fires or explosion in way of electrical equipment.

(c) Shock.

HULL

None.

MACHINERY

Not evidenced.

ELECTRICAL

There was no evidence of shock in way of electrical equipment.

(d) Pressure.

HULL

The only evidence of pressure is slight dishing of the flag bags and the tearing of canvas weather screens.

MACHINERY

Not evidenced.

ELECTRICAL

There was no evidence of pressure in way of electrical equipment.

(e) Effects peculiar to the Atom Bomb.

HULL

None.

MACHINERY

None.

ELECTRICAL

Radiant heat and radioactivity were evident on exposed surfaces. There was no damage to electrical equipment due to these effects.

III. Results of test on target.

(a) Effect on machinery, electrical, and ship control.

HULL

No comment.

MACHINERY

None.

ELECTRICAL

No damage was apparent to electrical machinery or ship control.

(b) Effect on gunnery and fire control.

HULL

No comment.

MACHINERY

No comment.

ELECTRICAL

No damage apparent.

(c) Effect on watertight integrity and stability.

HULL

None.

MACHINERY

No comment.

ELECTRICAL

No electrical damage affected watertight integrity or stability.

(d) Effect on personnel and habitability.

HULL

Personnel and habitability are not affected by damage to hull equipment.

MACHINERY

None.

ELECTRICAL

No electrical damage affected personnel or habitability.

(e) Effect on fighting efficiency.

HULL

None.

MACHINERY

None.

ELECTRICAL

No electrical damage affected the fighting efficiency of the vessel.

IV. General Summary.

HULL

None.

MACHINERY

The WAINWRIGHT was outside the effective range of the explosion in Test A.

ELECTRICAL

No damage was evident on any electrical equipment on this vessel. It appears that the effects of the A Bomb at the distance of this vessel from the center of the blast are not such as to require special designs or installation arrangements for electrical equipment.

V. Preliminary Recommendations.

HULL

None.

MACHINERY

None.

ELECTRICAL

None.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test; no flooding occured.

(b) Structural damage.

There is no structural damage of any consequence. One coat of paint on the exposed vertical surface of the port side of the superstructure and conning tower fairwater is scorched. The deck access cover to the windlass gear was apparently blown upward, fracturing the single remaining hinge which had not corroded through before the test. (There were originally three hinges). Two other small deck access covers, the fastenings of which were previously severly corroded, were blown off. This is one of the oldest operating submarines and her entire superstructure and main deck would have required replacement had she continued in active service.

(c) Other damage.

Machinery, electrical, ship control, and fire control equipment was fully operable after the test. Radio equipment temporarily inoperable due to loss of antennas caused by broken insulators. The master gyro showed a 7.5° easterly error and the auxiliary gyro a 6.4° easterly error after the test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

On the port side, 93% of the vertical and less than 10% of the horizontal paint is scorched. The apparent direction of the attack was 220° relative. As stated above, one coat of paint is scorched along the port side. The paint scorching is more severe on vertical than on horizontal surfaces. However, some horizontal surfaces show scorching. There are several examples of the reflection of the heat wave. Exposed topside cables and insulators were covered with light char or soot which could be rubbed off with the fingers, but in no case was insulation damaged.

(b) Fires and explosions.

No fires or explosions occured.

(c) Shock.

There is no evidence of shock other than broken non-standard 10" strain insulators which may have been broken by flying debris from other ships or by blast pressure.

(d) Pressure.

The blowing off of access covers as described in paragraph I(b) above indicate that a relatively small dynamic pressure wave attacked the superstructure. The "Coordinator's Report on Air Blast and Water Shock for Tests A and B" of 27 September 1946 indicates that the peak pressure was approximately 13.5 lbs. per square inch and the duration of the positive pressure phase was about 0.76 seconds. The elastic deformation of the single hull, measured at four stations, was not greater than 0.03 inches.

(e) Any effects peculiar to the atom bomb.

Sufficient heat to scorch paint on the port side and slight damage to the superstructure by a pressure wave were the only effects noted peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on Gunnery and Fire Control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull but the exposed topside personnel would have suffered severe flash burns. Habitability is unimpaired.

(e) Total effect on fighting efficiency.

There is no reduction in fighting efficiency from a material standpoint. Exposed personnel topside would have been at least temporarily out of action.

IV. General Summary of Observer's Impressions and Conclusions.

The SKIPJACK had been moored on the surface at a distance of approximately 1150 yards from the burst. From inspection, the impression is formed that this ship was subjected to a directional flash of more or less instantaneous heat followed by a relatively high velocity wind. It is concluded that a submairne on the surface at this distance from an explosion of the type

experienced in test Able will not be affected from a material standpoint but would have casualties among exposed topside personnel. Had the submarine been submerged, there would have been no damage and no casualties. For general views of the SKIPJACK after test Able see photographic section on pages [illegible].

V. Preliminary General or Specific Recommendations of Inspecting Group.

If it is expected that submarines will be subjected to such an attack it appears desirable to protect topside personnel to the maximum practicable extent with clothing and structural enclosures. As there is no significant material damage to this vessel no further recommendations are submitted herein.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test; no flooding occurred.

(b) Structural damage.

No structural damage was experienced.

(c) Other damage.

Machinery, electrical, ship control, fire control and electronic equipment was fully operable after the test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Direct radiant heat blistered and scorched the top coat of paint on exposed surfaces which were essentially normal to the rays. The heat flash apparently attacked the ship from about 135° relative. There is a very slight scorching of the outer coat of paint on the exposed vertical surfaces of the starboard side of the superstructure and conning tower fairwater. The scorching is greatest near the stern and decreases toward the bow. No scorching was noted on horizontal surfaces or where the vertical surfaces were shielded by other structure. There were no apparent reflections of the heat wave back onto a surface which did not face the blast. Topside cables in some few instances, where completely

exposed, had a light covering of char or soot which could be rubbed off with the fingers, but in no case was the insulation damaged.

(b) Fires and explosions.

None.

(c) Shock.

There is no evidence of shock.

(d) Pressure.

The "Coordinator's Report on Air Blast and Water Shock for Tests A and B" indicates that the peak pressure was approximately 5.5 lbs. per square inch and the duration of the positive pressure phase in the order of 0.94 seconds. Hull distortion in the torpedo rooms were less than 0.01 inches with no permanent set.

(e) Any effect peculiar to the atom bomb.

Heat, pressure and slight radioactivity were the only effects noted peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull. Habitability was unimpaired.

(e) Total effect on fighting efficiency.

There was no reduction in fighting efficiency from a material standpoint. Exposed personnel topside would have been at least temporarily out of action.

IV. General Summary of Observers' Impressions and Conclusions.

The SEARAVEN had been moored on the surface approximately 1750 yards from the center of the burst. From inspection, the impression formed is that this ship was subjected to a directional flash of more or less instantaneous heat followed by a relatively high velocity wind. It is concluded that a submarine on the surface at such a distance from an explosion of the type experienced in Test A will not be affected from a material standpoint but would have casualties among exposed topside personnel. Had the submarine been submerged there would have been no damage and no casualties. General views showing the SEARAVEN after the test are included in the Photographic Section on pages 29 to 35.

V. Preliminary Recommendation.

The only recommendation that can be made on the basis of damage to this ship is that insofar as practicable, topside personnel be shielded from flash burns by suitable clothing and enclosed stations. The report of the Commanding Officer of the USS SEARAVEN contains some recommendations based on damage to the USS SKATE which warrant careful investigation and consideration. However, since they are not based on damage to the SEARAVEN they are not included herein.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test, no flooding occurred.

(b) Structural damage.

No structural damage was experienced.

(c) Other damage.

Machinery, electrical, ship control, fire control and electronic equipment was fully operable after the test except the auxiliary gyro compass which was temporarily inoperable due to spillage of mercury.

II. Forces Evidenced and Effects Noted.

(a) Heat.

There is a very slight scorching of the outer coat of paint on the vertical surfaces of the starboard side of the superstructure and conning tower fairwater. No scorching was noted on horizontal surfaces or where the vertical surfaces were shielded by other structure. The heat flash appears to have come from 60° relative, although this indicates the TUNA had swung considerably to the right, compared with other submarines. There were no apparent reflections of the heat wave back onto a surface which did not face the

blast. On this ship, some frame numbers had been painted with yellow chromate in Pearl Harbor and then sprayed over with one coat of an outside haze gray. The scorching of this paint where it covered the chromate painted frame numbers was much more severe than in the immediately adjacent area where there was no chromate under coat. The numerals stood out in scorched paint as sharply as if they had been painted. This effect was duplicated where some green chromate had been applied over a weld and then covered with haze gray. Exposed topside cables in some few instances had a light coating of char or soot which could be rubbed off with the fingers, but in no case was the insulation damaged.

(b) Fires and explosions.

No fires or explosions occurred.

(c) Shock.

Shock transmitted to the auxiliary gyro compass, probably through the ship's structure, caused spillage of mercury from the gyro. This could have been caused by a deep roll of the ship but no evidence throughout the rest of the ship indicates the ship took that large a roll. The direction of this shock could not be determined. The auxiliary gyro is in the control room but there is no evidence to indicate this part of the ship was a shock area. This compass can be put in complete working order by pouring in mercury to replace that lost. No other equipment showed evidence of shock.

(d) Pressure.

The "Coordinator's Report on Air Blast and Water Shock for Tests A and B" of 27 September 1946 indicates the peak air pressure was approximately 4.0 lbs. per square inch and the duration of the positive pressure phase was about 1.0 second. The elastic deformation of the hull, measured at four stations, was less than 0.04 inches.

(e) Any effects peculiar to the atom bomb.

Pressure, heat, slight radioactivity and shock sufficient to spill mercury out of the auxiliary gyro compass were the only noted effects peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull but that exposed topside personnel would have suffered severe flash burns. Habitability is unimpaired.

(e) Total effect on fighting efficiency.

There is no reduction in fighting efficiency from a material standpoint. Exposed personnel topside would have been at least temporarily out of action.

IV. General Summary of Observers' Impressions and Conclusions.

The TUNA had been moored on the surface at a distance of approximately 2200 yards from the burst. From inspection, the

impression is formed that this ship was subjected to a directional flash of more or less instantaneous heat followed by a relatively high velocity wind. It is concluded that a submarine on the surface at this distance from an explosion of the type experienced in Test A will not be affected from a material standpoint but would have casualties among exposed topside personnel. Had the submarine been submerged, there would have been no damage and no casualties. For general views of the TUNA after Test A, see Photographic Section on pages 30 to 37.

V. Preliminary General or Specific Recommendations of Inspection Group.

If it is expected that submarines will be subject to such an attack it appears desirable to protect topside personnel to the maximum practicable extent with clothing and structural enclosures. As there is no significant material damage to this vessel no further recommendations are submitted herein.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Before the test the drafts were 15' - 0" forward and 15' - 7" aft. The ship had a 1/2° list to starboard. Draft readings after the test are not available as the ship was beached before the Initial Boarding Team was permitted to make an inspection. After the vessel was hauled off the beach the readings were 16' - 2" forward and 17' - 9" aft. There was a 2 or 3 degree list to starboard due to flooding of six main ballast tanks and the displacement of damaged structure to starboard. It is believed that one or two of the flooded tanks had been blown during the unbeaching operation.

(b) Structural damage.

The pressure hull, including the conning tower, is intact and undamaged except for the port side of frame 55 just above the tank top where 24 inches of the frame welding cracked. This was due to the blast pressure on the conning tower and shears above; the pressure hull plating is not distorted or damaged. There is no structural damage to compartments. The ballast tanks are intact insofar as structure is concerned, having suffered only minor denting. All damage of consequence is confined to the area above the pressure hull where the superstructure and weather deck are demolished from frame 10 aft to the stern. The conning tower fairwater and bridge are completely demolished. The non-watertight bow, pivoting at frame 10, appears to have moved to starboard through a very small angle (2 or 3 degrees). The stern above the waterline aft of frame 132 is displaced parallel to the hull axis a distance of 8 inches and crushed in on the port side. The periscope and radar shears are bent about 15° and 25° to starboard respectively, as a result of failures at the connection to their foundations. Aft of the conning tower most of the decking,

the majority of the free-flooding superstructure, many fittings, and most of the piping was bent, damaged by blast, or blown over the side. The bridge structure was opened up and folded together upon itself in front of the conning tower. Nearly half of the superstructure forward was wrecked. See page 2 of Volume II for a general view of this damage.

(c) Other damage.

Both periscopes, the radar masts, bow buoyancy vents, No. 7 main ballast tank vent and the main induction valve are inoperable due to distorted shafting. Nos. 2, 4, and 6 torpedo tubes are inoperable due to leaky or ruptured impulse air lines and Nos. 7 and 8 tubes are inoperable due to distorted shutters. The debris and torn metal topside had sheared, cut, or torn loose practically every cable leading through the superstructure. The sidelights were shattered. The stern light was missing. The after windlass was inoperable due to the fact the drum and its shaft had been bent over by the blast.

Electrical equipment was operable except for the following items:

1. The main gyro compass.
2. The auxiliary gyro compass.
3. The voltage and speed regulators for the three I.C. motor-generator sets (ability to hand control was not affected).
4. The running lights.
5. Instruments on the bridge (due to parted cables).
6. Power drive on after gyro setting indicator regulator.
7. 1 and 7 MC bridge reproducers.

All electronic equipment was inoperable except the WCA sonar equipment.

All ship control and propulsion machinery inside the pressure hull was undamaged and operable when tested.

II. Forces Evidenced and Effects Noted.

(a) Heat.

A heat flash appears to have come from about 220° relative. The scorching mentioned in paragraph I above is believed to have affected only the outside coat of paint. The damage to topside light plating is so severe that the remaining evidence of paint scorching is not sufficient to form the basis for any significant conclusions.

There was no evidence of heat having affected any equipment inside the pressure hull. Topside cables in a few instances, particularly those high on the superstructure and on the periscope shears, had a light covering of char or soot which could be rubbed off with the fingers, but in no case was insulation damaged due to heat alone. Some scorched paint remains in protected spots but it appears that scorching was minor and that most of the scorched paint was blown off. This effect seemed to be less on the SKATE than on other target submarines.

(b) Fires and explosions.

There is no evidence of fire or explosions.

(c) Shock.

Damage from shock was not extensive. Torpedo tube cradles were distorted. This distortion is of such nature as to indicate that the ship (at least the two ends) moved violently and suddenly to starboard. If such motion is assumed, the distortion of the torpedo cradles is due to the inertia of the torpedoes stowed in these cradles. Mountings of the QLA sound stack in forward torpedo room and TBL transmitter in radio room failed. These failures could have been due to extreme rolls of vessel. Shock is believed the cause of failure of the upper support bearing of the sound stack after bearing repeater in the conning tower, clock lens in the after engine room, shattered hard rubber battery

ventilation duct in the forward battery tank, and shattering of 6 light bulbs in the after torpedo room. A combination of shock and roll caused a spillage of mercury from both the main gyro compass and the auxiliary gyro compass. Shock was the probable cause of the loss of adjustment on the voltage and speed regulators for three I.C. motor-generators and their failure to function after the test. Roll and shock together caused the shattering of the threads on tie-rod nut holding battery cells of the forward battery.

(d) Pressure.

The salient force causing damage appears to have been a blast or high velocity wind of relatively long duration, and of such intensity as to apply a high pressure to exposed surfaces parallel to the wave front. This wind demolished all the topside structure and may have caused the displacement of the non-watertight stern structure, but caused no direct damage to the pressure hull. It appears to have come from the port quarter.

The exposed tank top plating on the port side aft of frame 70 was dished somewhat between frames, apparently as a result of pressure. Between frames 70 and 75 port (in way of No. 5 fuel ballast tank) there is one continuous dent in the plating and frames which has a maximum deflection of six inches. There is no convincing evidence that this dent was caused by the falling of some heavy object. It is therefore assumed to be the result of pressure. The explanation of why this particular area is dished so much more than adjacent similar structure could lie in the fact that between frames 73 and 78 the tank top plating is overhung by a gun sponson which may have locally intensified the pressure by reflecting the wave down onto the tank top.

(e) Effects apparently peculiar to the atom bomb.

Besides the heavy blast effect discussed above, the SKATE was rendered slightly radioactive, which required three days to decay to the point where the crew could reboard with safety. There are also indications, such as slight spillage of acid from the cells of the batteries, that the ship took an extremely heavy roll.

III. Effect of Damage.

(a) Effect on machinery, electrical and ship control.

Except that the bridge and most mooring fittings were blown away, the structural damage had no vital effect on surface operation. After removal of the manhole cover in the top of bow buoyancy tank in order to vent this free-flooding tank, the ship could probably have submerged. The normal bow buoyancy valves could not be opened due to badly distorted linkage. In the event of submerging the main induction would have flooded (via the fracture at the base of the main induction valve and the space between the operating shaft for this valve and its guide bearing), thus roughly compensating for the weight lost in topside structure. However, at any speed other than dead slow, submerged resistance would have been enormously increased and control of the vessel difficult if not impossible due to the unsymetrical resistance of the damaged structure. The periscopes would have been useless for observation and there would probably have been numerous minor leaks as a result of damaged topside fittings. The ship was operated on the surface for approximately 3 hours underway to test main propulsion machinery in all combinations. This operation was satisfactory and no change in propulsion and ship control machinery had taken place. See photograph on page 3 of Volume II.

(b) Effect on gunnery and fire control.

It may be possible to fire numbers 1, 3, 5, 9 and 10 torpedo tubes although misalignment of the shutters on tubes 9 and 10 is suspected. The remaining five tubes were out of action, for reasons described in paragraph I (c) above. Only one gun was mounted and this damaged beyond use. Had the other guns been mounted they would probably be out of action due to interference from demolished structure if not actually damaged. Fire control is restricted to input from the JK-QC sound gear, as periscopes, radar antennae and TBT's are useless.

(c) Effect on watertight integrity and stability.

The watertight integrity of the pressure hull is

not affected except for minor leaks due to damaged topside fittings. Main ballast tanks Nos. 2B, 2C, 2D, 6B and 6C flooded slowly to the waterline as a result of damaged salvage valves. Main ballast tank No. 7 flooded as a result of a damaged main vent valve. The total loss of reserve buoyancy was 35%.

(d) Effect on personnel and habitability.

Aside from possible radiological casualties, it is estimated that all topside but no interior personnel would have been lost. Habitability within the ship is 100% and no noxious gases were detected. (The hydrogen found in the battery compartments is believed to be only the accumulation of four days normal concentration). Topside habitability is virtually 100% destroyed as far as fighting or operating the ship in a seaway is concerned.

(e) Total effect on fighting efficiency.

The one installed gun, a minimum of one half the torpedo tubes and almost all means of obtaining fire control data were destroyed. The ship could not operate submerged (except possibly to a very minor extent) and surface operation in the open sea would be all but impractical. It is therefore estimated that the fighting efficiency was reduced by 90%.

IV. General Summary of Observers' Impressions and Conclusions.

The SKATE was moored on the surface at a distance of approximately 400 yards from the center of the burst. At this range, the force of the blast was sufficient to completely demolish the non-watertight structure above the waterline but caused little or no damage to the pressure hull. This is exactly the reverse effect from that of a depth charge which attacks only the pressure structure. It is considered that the water provided excellent protection, even for light structure below the waterline, and that, had the submarine been submerged, she would have suffered very little if any damage. However, there can be little doubt that a submarine on the surface would be most effectively

put out of action by an atomic bomb explosion such as that of Test A at the range prevailing for that test. It is believed that if unmolested, the ship could have proceeded back to port through moderate seas. It is estimated that a good submarine repair yard could restore the ship to her original condition in four weeks or less.

V. Preliminary General or Specific Recommendations of Inspection Group.

To permit submarines to better withstand the blast effect of the atom bomb, it is necessary that topside structure fittings and hull openings be reduced to an absolute minimum and the unavoidable remainder strengthened and/or protected as much as weight will permit. Such a trend is also desirable from the viewpoint of increasing submerged speed. If submarines abandon surface operation in the open sea much of the top hamper will lose its function and can be automatically eliminated. The rest should be pared to the bone, by drastic redesign of the entire ship if such is necessary.

Specific recommendations to accomplish the above are as follows:

1. Reduce surface silhouette by reducing height of periscope and radar mast supports and full length superstructure. Wood deck should be entirely eliminated and plating above pressure hull should be faired, rounded, fairly heavy and only high enough above pressure hull to enclose absolutely essential external fittings.

2. Eliminate as many as possible of pressure hull openings and external hull fittings including salvage fittings.

3. Increase the strength and protection of main vents and other essential external fittings.

4. Increase strength of securing straps and fittings for external items as mufflers, piping, electric wiring, etc. These items should be faired in as close to the pressure hull as possible and secured to structural members rather than to hull plating.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test; no flooding occurred.

(b) Structural damage.

There was no structural damage of any consequence. Three perforated swash bulkheads (about 10 pound plates), that extend from the main deck to the pressure hull at frames 32, 44 and 60 respectively, are bulged forward. The maximum depth of bulging is about 2 inches. Apparently the blast pressure entered the semi-closed space between the main deck and the pressure hull and dished these bulkheads before it was dissipated through the numerous openings. It is interesting that the bulkhead at frame 44 was dished forward although it forms the after boundary of the space between frames 32 and 44. This would seem to indicate that the cause of these deformations was true blast rather than a uniform pressure within the space, acting in all directions.

(c) Other damage.

Machinery, electrical, ship control, fire control and electronic equipment was fully operable after the test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

The top coat of paint on the exposed vertical surface of the port side of the superstructure and conning tower fairwater

is moderately scorched and charred. The scorching is less than on the SKIPJACK and PARCHE which were further from the explosion, probably because the explosion bore about 200° relative. Topside cables in some few instances, where completely exposed, had a light covering of char or soot which could be rubbed off with the fingers, but in no case was the insulation damaged.

(b) Fires and explosions.

No fires or explosions occurred.

(c) Shock.

There is no evidence of shock.

(d) Pressure.

The dishing of the swash bulkheads described in I(b) above indicates that a relatively small dynamic pressure wave attacked the superstructure. The 'Coordinator's Report on Air Blast and Water Shock for Test Able and Baker' indicates that the peak air pressure was approximately 20 lbs. per square inch and the duration of the positive pressure phase was about 0.65 seconds. Elastic deformation of the single hull, measured at four stations, was less than 0.03 inches.

(e) Any effects peculiar to the atom bomb.

Slight radioactivity and heat as well as the pressure wave mentioned in II(d) above were the only effects noted peculiar to the atom bomb.

III. Effects of damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull but that exposed topside personnel would have suffered severe flash burns. Habitability is unimpared.

(e) Total Effect on fighting efficiency.

There is no reduction in fighting efficiency from a material standpoint. Exposed personnel topside would have been at least temporarily out of action.

IV. General Summary of Observers' Impressions and Conclusions.

The APOGON had been moored on the surface at a distance of approximately 975 yards from the burst. From inspection the impression is formed that this ship was subjected to a directional flash of more or less instantaneous heat followed by a relatively high velocity wind. It is concluded that a submarine on the surface at this distance from an explosion of the type experienced in test A will not be affected from a material standpoint but would have casualties among exposed topside personnel. Had the submarine been submerged, there would have been casualties. For general views of the APOGON after Test A see photographic section on pages 27 to 34.

V. Preliminary Recommendations.

If it is expected that submarines will be subject to such an attack it appears desirable to protect topside personnel to the maximum practicable extent with clothing and structural enclosures. As there is no significant damage to this vessel no further recommendations are submitted herein.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test; no flooding occurred.

(b) Structural Damage.

There was no structural damage.

(c) Other Damage.

Machinery, electrical, ship control, fire control and electronic equipment was fully operable after the test except the starboard side-light and the stern light had broken filaments.

II. Effects of Damage.

(a) Heat.

There is a very slight scorching of the outer coat of paint on the vertical surfaces of the starboard side of the superstructure and conning tower fairwater. No scorching was noted on horizontal surfaces or where the vertical surfaces were shielded by other structures. The heat flash appears to have come from approximately 110° relative. There were no apparent reflections of heat wave back onto a surface which did not face the blast. The scorching is more severe near the top of the periscope shears than lower on the conning tower fairwater.

(b) Fires and explosions.

No fires or explosions occurred.

(c) Shock.

The starboard sidelight and the stern light were damaged by shock. The damage was confined to the globes. They were not shattered but the filaments were broken. The lights operated properly when new globes were installed. The blast seemed to hit the ship well on the starboard quarter. No other equipment showed any effects due to shock.

(d) Pressure.

The "Coordinator's report on air blast and water shock for Tests A and B" of 27 September 1946 indicates that the peak air pressure was approximately 5.0 lbs. per square inch and the duration of the positive pressure phase was about 0.95 seconds. The elastic deformation of the single hull, measured at four stations, was less than 0.0103 inches.

(e) Effects apparently peculiar to the atom bomb.

An unusual evidence of the brief duration of heat from the atom bomb blast was noted on the after cigarette deck. Although the starboard side of the thermometer was burned and blistered, the high temperature did not last long enough to raise the thermometer reading above 96°F. Other effects were pressure and slight radioactivity.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull, but that exposed topside personnel would have suffered severe flash burns. Habitability was unimpaired.

(e) Total effect on fighting efficiency.

There is no reduction in fighting efficiency from a material standpoint. Exposed personnel topside would have been at least temporarily out of action.

IV. General Summary of Observers' Impressions and Conclusions.

The DENTUDA had been moored on the surface at a distance of approximately 1900 yards from the burst. From the inspection the impression is formed that this ship was subjected to a directional flash of more or less instantaneous heat followed by a relatively high velocity wind. It is concluded that a submarine on the surface at this distance from an explosion of the type experienced in Test A will not be affected from a material standpoint but would have casualties among exposed topside personnel. Had the submarine been submerged, there would have been no damage and no casualties. For general views of the DENTUDA after Test A see photographic section on pages 30 to 37.

V. Preliminary Recommendations.

If it is expected that submarines will be subject to such an attack it appears desirable to protect topside personnel to the maximum extent with clothing and structural enclosures. As there is no significant material damage to this vessel, no further recommendations are submitted herein.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test; no flooding occurred.

(b) Structural damage.

There was no hull damage other than paint scorching on the port side, a very slight dishing of some 5 pound plating on the port side of the conning tower fairwater, and the blowing in of a small (24" x 20") access door in the same plating.

(c) Other damage.

Machinery, electrical, ship control, fire control and electronic equipment was undamaged and fully operable after the test. The PARCHE was one of the vessels selected to have certain electronic and fire control equipment in operation during the test. This was accomplished by taking power from the after battery through special timing relays as discussed in the Electrical Section of this report.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Momentary extreme heat is evidenced by heavily scorched and blistered paint on surfaces toward the blast.

The flash apparently came from 270° relative. The top coat of paint on the exposed vertical surfaces of the port side of the superstructure and conning tower fairwater is moderately scorched. On this ship there is also evidence of reflected heat. That is, some vertical surfaces (such as the inboard side of the port bridge bulwark), which face 180° away from the explosion, are scorched. The paint scorching is only one coat deep but is slightly more severe than on other submarines nearer the center of the explosion. This is probably due to the fact that the ship (hence most vertical surfaces) lay almost perpendicular to the direction of propogation of the heat wave, whereas other submarines lay at an oblique angle. On this ship, a few horizontal under surfaces are also scorched, but most of the scorching is confined to vertical surfaces. See photographs on pages 30 to 35. Topside cables in some few instances had a light covering of char or soot which could not be rubbed off with the fingers, but in no case was the insulation damaged.

(b) Fires and explosions.

No fires or explosions occurred.

(c)Shock.

There is no evidence of shock.

(d) Pressure.

Slight dishing of the port side of the conning tower fairwater plating indicates that a dynamic pressure wave struck the port side. The "Coordinators Report on Air Blast and Water Shock, Tests Able and Baker" of 27 September, indicates that the peak pressure was approximately 6.8 lbs. per square inch and the duration of the positive pressure phase in the order of 0.88 seconds.

Elastic distortion of the hull, measured at four stations, was not greater than 0.04 inches.

(e) Effects apparently peculiar to the atom bomb.

Heat, pressure and slight radioactivity were the only noted effects peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery, electrical, and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on water-tight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull. Habitability was unimpaired. It is estimated that topside personnel would have suffered severe flash burns.

(e) Total effect on fighting efficiency.

There was no reduction in fighting efficiency from a material standpoint. Exposed topside personnel would have been at least temporarily out of action.

IV. General Summary of Observers' Impressions and Conclusions.

The PARCHE had been moored on the surface at a distance of approximately 3000 yards from the center of the blast. From inspection, the impression formed is that this ship was subjected to a directional flash of more or less instantaneous

heat followed by a relatively high velocity wind. It is concluded that a submarine on the surface this distance from an explosion of the type experienced in Test A will not be affected from a material standpoint bu would have casualties among exposed topside personnel. Had the submarine been submerged, there would have been no damage and no casualties.

V. Preliminary General or Specific Recommendations of Inspection Group.

If it is expected that submarines will be subjected to such an attack it appears desirable to protect topside personnel to the maximum practicable extent with clothing and structural enclosures. As there is no significant material damage to this vessel no further recommendations are submitted herein.

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test

(a) Drafts after test; list; general areas of flooding, sources.

Draft and list were normal after the test; no flooding occurred.

(b) Structural damage.

No structural damage was experienced.

(c) Other damage.

Machinery, electrical, ship control, fire control and electronic equipment was fully operable after the test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

Direct radiant heat blistered and scorched the top coat of paint on exposed surfaces which were essentially normal to the rays. The direction of the flash was clearly shown to be within a few degrees of 100° relative and almost exactly horizontal. The scorching of the superstructure paint extends the whole length of the superstructure on the starboard side while the vertical distribution of char indicates that the most severe heat was in the upper half of the periscope shears gradually decreasing from the half way mark down to the bottom of the superstructure where the char is almost negligible. Except for about 5 of the largest paint char bubbles the penetration was limited to the outer layer of paint. The largest char spots are about one inch in diameter on the shears and show penetration of three layers of paint. Bitumastic, wood, and grease where exposed show nothing. Topside cables, in some few instances where completely exposed, had a light covering of char or soot which could be rubbed off with the fingers but in no case was insulation damaged. The heat indicating instruments mounted topside all show the presence of heat

and those equipped with lenses are particularly interesting in that the heat penetrated even very thin metal. No scorching was noted on horizontal surfaces or where the vertical surfaces were shielded by other structure. There were no apparent reflections of the heat wave back onto a surface which did not face the blast.

(b) Fires and explosions.

No fires or explosions occurred.

(c) Shock.

There is no evidence of shock.

(d) Pressure.

The "Coordinator's Report on Air Blast and Water Shock for Tests A and B" of 27 September 1946 indicates that the peak air pressure was about 3.4 lbs. per square inch and the duration of the positive pressure phase approximately 1.2 seconds.

(e) Any effects peculiar to the atom bomb.

Slight radioactivity and heat as well as the pressure wave mentioned in II(d) above were the only effects noted peculiar to the atom bomb.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

It is believed there would have been no effect on personnel inside the sealed pressure hull but that exposed topside personnel would have suffered severe flash burns. Habitability is unimpaired.

(e) Total effect on fighting efficiency.

There is no reduction in fighting efficiency from a material standpoint. Exposed personnel topside would have been at least temporarily out of action.

IV. General Summary of Observers' Impressions and Conclusions.

The PILOTFISH had been moored on the surfact at a distance of approximately 2500 yards from the burst. From inspection, the impression is formed that this ship was subjected to a directional flash of more or less instantaneous heat followed by a relatively high velocity wind. It is concluded that a submarine at this distance from an explosion of the type experienced in Test A will not be affected from a material standpoint but would have casualties among exposed topside personnel. Had the submarine been submerged, there would have been no damage. For general views of the PILOTFISH after Test A see photographic section on pages 26 to 33.

V. Preliminary General or Specific Recommendations of Inspecting Group.

The only recommendation that can be made on the basis of damage to this ship is that insofar as practicable, topside personnel be shielded from flash burns by suitable clothing and enclosed stations. The report of the Commanding Officer of the U.S.S. PILOTFISH contains some recommendations based on the damage to the U.S.S. SKATE which warrant careful investigation and consideration. However, since they are not based on damage to the PILOTFISH they are not included herein.

Defense Special Weapons Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398

TRC

10 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OMI/Mr. William Bush

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency (formerly Defense Nuclear Agency) Security Office has reviewed and declassified the following reports:

AD-366718	XRD-32-Volume 3
AD-366726	XRD-12-Volume 2
AD-366703	XRD-16-Volume 1
AD-366702	XRD-14-Volume 2
AD-376819L	XRD-17-Volume 2
AD-366704	XRD-18
AD-367451	XRD-19-Volume 1
AD-366705	XRD-20-Volume 2
AD-376028L	XRD-4
AD-366694	XRD-1
AD-473912	XRD-193
AD-473891	XRD-171
AD-473899	XRD-163
AD-473887	XRD-166
AD-473888	XRD-167
AD-473889	XRD-168

AD-366705

TRC 10 April 1997

SUBJECT: Declassification of Reports

AD-B197749	XRD-174
AD-473905	XRD-182
AD-366719	XRD-33 Volume 4
AD-366700	XRD-10
AD-366712	XRD-25 Volume 1
AD-376827L	XRD-75
AD-366756	XRD-73
AD-366757	XRD-74
AD-366755	XRD-72
AD-366754	XRD-71
AD-366710	XRD-23 Volume 1
AD-366711	XRD-24 Volume 2
AD-366753	XRD-70
AD-366749	XRD-66
AD-366701	XRD-11
AD-366745	XRD-62.

All of the cited reports are now **approved for public release; distribution statement "A" applies.**

Ardith Jarrett

ARDITH JARRETT
Chief, Technical Resource Center

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